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ABSTRACT

This book covers a representative sample of the types of technology developed by the South African Human Sciences Research Council (HSRC). It is divided into five sections: (1) "Introduction" (Andries R. van den Berg); (2) "Technology for Education and Training" (A. Cecilia Bouwer); (3) "Technology for Managing Human Resources" (Terry R. Taylor); (4) "Human Sciences Technology in Managing Problems Arising from Social Issues" (Arie G. Oberholster); and (5) "Future Perspectives" (Roelf J. Prinsloo). The aim of the book is to indicate social and organizational needs that could be addressed through human sciences technology. This publication serves three functions: to create a greater awareness of the fact that the human sciences need not be restricted to describing and explaining what is going on in society; to stimulate students in the human sciences with a listing of a wide array of technology; and to promote cooperation with other professionals and stakeholders in utilizing the potential of the human sciences to improve the quality of life of all South Africans. References are included with each section. (TMK)

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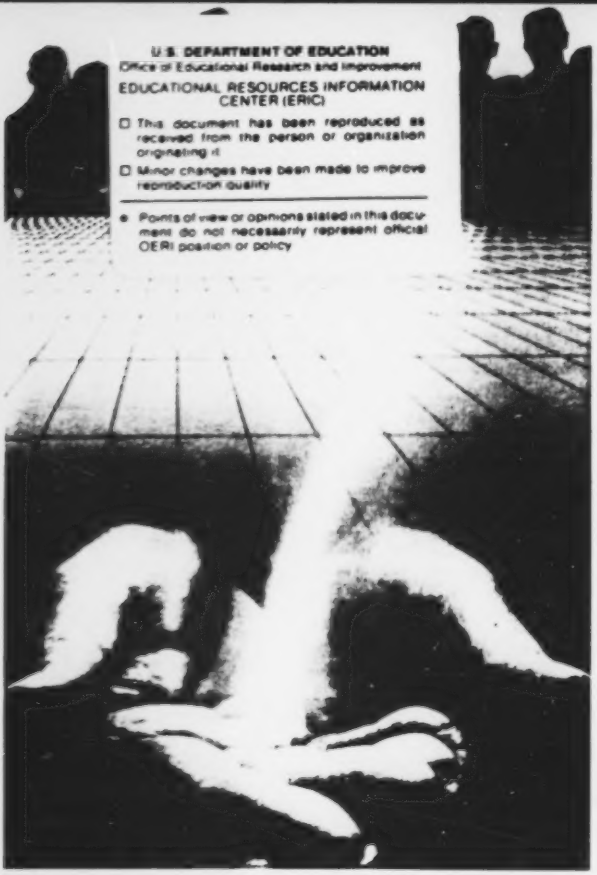

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HUMAN SCIENCES TECHNOLOGY:

Ways of solving problems in the human domain

IKO/6532

Editor: RJ Prinsloo

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Editor: R J Prinsloo

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Preface — Human Sciences Technology: Long past and short history

Human sciences technology dates back to the emergence of modern science in the 18th and 19th centuries. It was during that period that the foundations were laid for the development of applications of scientific information. Examples that readily come to mind include the precursors to psychological measurement, demographic and social formulae, educational and instructional instruments, etc. It is only recently, however, that some scholars have begun to argue that the term "technology" as such can also be applied to this category of transformed information and knowledge in the human sciences.

But the idea of technology in the human sciences has not yet found unconditional acceptance. It is unfortunately not always clear what lies at the root of the opposition to the term "human sciences technology". There have been a number of arguments against the use of this term and some of the more important ones are the following. First, there is the ontological view that the object of study in the human sciences (namely the person in all his/her relationships, actions, etc.) is so unique and complex that he/she cannot be reduced to quasi-(natural) scientific models, instruments, etc. This type of argument can readily be seen in hermeneutics and phenomenology. The second category of argument against technology in the human sciences derives from scholars engaged in the critique of culture. Some of the more important contributions have been made by the Neo-Marxists (*inter alia* through their opposition to logical positivism), the counterculture writings of Jaques Ellul and post-modernism (equating technology with scientism and modernism). Another related type of criticism is more moral in nature in the sense that human sciences technology is equated with social engineering and all the dysfunctions it has brought in its wake. A different kind of opposition to human sciences technology can be inferred

from the comments made by some critics which give the impression that they do not see human sciences technology as the outcome of the research process, reading meanings into the term not originally intended.

The above reference to criticism of technology in general, and perhaps more so of human sciences technology in particular, should be seen as a warning against an uncritical and naive acceptance of human sciences technology as the ultimate solution to some of the problems plaguing modern society. Technology should always be viewed against the background of the original theory and method from which it is derived and within the context within which it is applied. Clearly, the human scientist should be wary of the dangers of a "technisistic seduction" (Mouton) and the trap of confusing technology with technocracy. In this regard, Rossouw's succint analysis of these concepts can be used as a pointer. Among other things he argues that technique and technology should not be equated with technocracy and that there is no intrinsic reason for tension between the humanities (the focus of his analysis) and technology. His analysis further shows that the nature of some of the disciplines in the human sciences is such that technology can be obtained from them.

The preceding considerations also have a bearing on a fairly common criticism levelled at the human sciences, namely that they are too open-ended and not sufficiently concerned with the problems associated with the implementation of research findings. This view of the human sciences should not be ignored at a time when social problems in particular are threatening many countries and funds for research are declining sharply. One of the many ways of addressing this dilemma could be through the development of research-based human sciences technology.

This was in fact the opinion of Kenneth Prewitt, past President of the Social Sciences Research Council in the US, when I spoke to him in 1982 about the utilization of human sciences findings. The same view was also held by persons like Roberta

Miller and Lee Sechrest who were actively involved in the Consortium of Social Science Associations (COSSA) which was founded in that year. The purpose of the consortium was to promote and lobby the case of the social sciences following the cut made by President Reagan in the federal appropriation for the social sciences. The discussions I held with Prewitt, Miller, Sechrest and others helped shape my own views on human sciences technology in important respects.

Since its establishment, the Human Sciences Research Council (HSRC) has been actively involved in the development of human sciences technology in the form of the construction of psychological and educational tests and instruments, and the design of training courses, remedial packages and organisational audits. These activities are, however, not explicitly defined as human sciences technology, but rather as the application of research findings. It was only after the state introduced the policy of framework autonomy, which required the HSRC to earn an increasing portion of its budget through contract work, that it was realized that greater importance should be attached to technology development. The emerging view was that while the HSRC should be involved in research on nationally important issues, the development and marketing of human sciences technology would be a useful strategy to address some of the pressing needs experienced by various organizations and institutions. This conscious attempt to promote human sciences technology led to the adoption of an in-house policy in this regard.

The HSRC's policy on human sciences technology defines technology as "an ongoing process of developing, structuring, applying, adapting and evaluating human and non-human resources within the broad field of the human sciences to meet the needs of society and market needs". It further commits the HSRC to

- investing a portion of its resources in the development and/or adaptation of technology,

- undertaking proper needs assessments,
- ensuring the validity of the technology,
- catering specifically for poor communities, and
- adhering to the principles of responsibility, quality, participatory methodology and sound economic policy while it at the same time being accountable to society, respondents and clients.

The technology policy should be read in conjunction with the research code, which means that all the ethical criteria applicable to research activities apply equally to the development and application of human sciences technology.

This book covers a representative sample of the types of technology developed by the HSRC. As such, it does not pretend to be a treatise on the methodology of the development of technology in general or of particular instances of technology. Its aim is to indicate some social and organizational needs that could be addressed through human sciences technology. It follows that the description of examples of such technology is often brief. In most cases, though, reference is made to the research that led to the development of the particular technology. Researchers involved in the development of technology are very sensitive to the need to base the design of such technology on sound research, as well as the need to test empirically and otherwise the effectiveness (validity, relevancy, reliability) of the product.

I trust that this publication will serve at least three functions: First, that it will create a greater awareness of the fact that the human sciences need not be restricted to describing and explaining what is going on in society. Important as those primary scientific functions are, they often fail to assist the professional and practitioner directly in doing something about a problem. It is hoped that this publication will focus attention on the often unrecognized potential of the human sciences to go beyond description, explanation and understanding by offering standardized techniques, instruments and designs for

addressing some of the challenges which regularly confront organizations and society at large.

Secondly I hope that students in the human sciences will be stimulated by the wide array of technology listed in this publication. It is important that students realize the possibilities (and limitations) of their disciplines in order to make them think more creatively and innovatively about their own professional development.

Finally the book is intended to promote co-operation with other professionals and stakeholders in utilizing the potential of the human sciences to improve the quality of life of all South Africans.

H.C. Marais

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This book is dedicated to Dr J.G. Garbers, former President of the HSRC and to Dr H.C. Marais, Deputy President of the HSRC who originally used the term human sciences technology and who motivated the authors to write this book.

Special thanks go to Dr Marais for his valuable comments on an earlier version of the manuscript. It goes without saying, however, that the responsibility for the final version rests with the authors.

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Finally to my fellow authors who embarked upon this venture with me, thank you for your patience and co-operation at times when progress was very slow.

R.J. Prinsloo

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A.R. van den Berg.

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He specialises in the mathematical and statistical aspects of the development and standardization of psychological and educational tests and has a special interest in the strength and nature of the relationship between cognitive development and socio-economic deprivation.

He has contributed to various publications on test theory and was one of the first persons in South Africa who contributed significantly to computerized item banks.

1

INTRODUCTION

A.R. van den Berg

The concept of technology

The application of the "laws of nature" by the human race to secure its existence has probably been in use since time immemorial. The very existence of humans, as with all other forms of life, depends on the "laws of nature" and the interaction between the organism and the environment through the manifestation of these laws. To what degree human beings will ever "understand" these laws has been debated by cosmologists and philosophers throughout the ages. The urge of humans to know or understand "why everything is the way it is" has led them to extend their inquiries not only into the depths of space, into the minute intricacies of the atom, into the complex structure of the molecules that are believed to be the building blocks of life, but also into the structure and functioning of the human brain. Human beings are social animals. Their biological make-up determines that their basic needs can only be satisfied if they co-operate with other humans. For this co-operation they need to heed and apply the "laws of human nature". A belief that useful laws of human nature do in fact exist is a logical prerequisite for the writing of this book. It is, however, vital to remember that all such "laws" can only be formulated in terms of probabilities. Even the basic "law" that all human beings must die has become less certain in the light of the transplantation of human organs and cryogenics which hold the possibility that advanced life forms may one day be frozen and kept dormant for an indefinite time and later be revived by controlled thawing.

Science can be seen as an enterprise which involves method, facts, and abstract theory. Scientific method, often called research, is characteristically systematic and does not seek to impose people's desires and hopes of people upon the flux of things. Theories must be supported by logically acceptable evidence, which must be weighed carefully and tested with the canons of necessary and probable inference. By virtue of its method, the enterprise of science is a self-corrective process.

In spite of the lofty ideals of science, humans do desire to improve their quality of life. Technology is needed for this. When knowledge, tools, and skills are applied to solve practical problems and to extend human capabilities, one may say that *technology* has been applied. In other words, technology may be viewed as that body of knowledge, skills, and systems that is utilised by humans to produce economic goods,or to develop more advanced capabilities to produce economic goods. Technology is different from science. Science is aimed at understanding while technology is aimed at doing, making, and implementing.

The origin of the knowledge that is implied in the definition of technology, comes from the combined field of *science and technology*. It may be obtained from the body of science, from everyday experience, from art, from sudden insight, or from any other source. Of course, the principles of science, whether discovered or not, always underlie technology. There are, however, a great many examples where discovered technology has preceded or even spawned the discovery of the scientific principles or laws on which it is based. There is little doubt that today the most reliable and consistent source of relevant knowledge is *research and development* (R&D) that is specially undertaken to obtain solutions to clearly defined problems. Admittedly, it is not always clear where science ends and development with the aim to apply new knowledge begins. Because unbridled undirected search for new knowledge is not affordable even by the most advanced economies in the world, most research today can be labelled *applied research*, i.e. research aimed at obtaining knowledge that can be used in producing technology. However, the role of basic research to ensure the survival of the human race cannot be denied. At the time of writing, newspapers report that the USA government is aiming to increase its budget for basic research by 50 percent.

The impact of technology on society

Nearly 400 years ago Francis Bacon wrote that "knowledge is power". Today we would say rather less poetically that science is essential for efficient technology. The human urge to know seems sometimes to have been displaced by a materialistic urge to make useful things. In present times those nations producing most of their economic goods and services using technology that is extensively based on knowledge derived from modern science seem to thrive economically, while nations that struggle economically seem to use little or none of the latest scientific discoveries in their technology. The nations at the top of the economic ladder are those at the forefront in producing scientific knowledge on which new technology may be based. The nations at the middle of the economic ladder are those with people who are able to understand, and build technology on scientific principles. The nations that rely on technology which is generated elsewhere to produce economic goods and services may attain an acceptable general living standard. But the nations lacking citizens who are able to utilise modern technology for production are likely to vanish, or to enter a state in which they have to be benevolently or paternalistically "protected" by more advanced nations.

The aims of this book

The views presented above lead to the conclusion that a nation wishing to thrive economically, or in other words, achieve a generally high standard of living, is compelled to work for the advancement of science and the development and use of scientifically based technology. This book concerns the technology based on the human sciences, a sphere of the sciences that is, unfortunately, not generally regarded as producing knowledge on which technology can be based. The concept of *human sciences*, as used here, is meant to include the fields that are often referred to as the *humanities*, the *social sciences*, and the *behavioural sciences*. The misconception that the human sciences

cannot spawn the production of technology—that is, methods of doing, making and implementing—often leads to an undervaluation of the technology based on the human sciences, which in turn leads to underinvestment in the advancement of the human sciences. This is particularly disquieting in the light of the fact that the most serious problems of the day are rooted in improper human development and dysfunctional human interaction.

The aims of this book therefore include the following:

(i) To give decision makers in all sectors of the economy in Southern Africa an overview of the broad spectrum of human sciences technology at their disposal for immediate implementation, or which could be produced at relatively short notice for implementation. Although there are undoubtedly many other examples of human sciences technology, it has been decided to restrict the illustrations in this volume to the technology which has been produced by the HSRC.

(ii) To illustrate the return of investment by the government through the HSRC, in the advancement of the human sciences.

(iii) To focus on future developments in human sciences technology.

The role of values

Human beings would probably be unable to cope with the vicissitudes of life without adopting beliefs and values that can guide their actions and help them to control their emotions. Because humans are social animals with biological and material needs, conflicts of interest are certain to arise between individuals and between identifiable groups of people. Such conflicts of interest form the basis of politics, while values form the basis of the rules by which such conflicts are resolved. It should be clearly stated that political priorities in the funding, execution, and

implementation of social sciences and technology cannot be value-free or divested of such conflicts of interest, particularly those in the sphere of politics. Although political issues cannot be reduced to technical issues, the application of technology can modify, or intensify, political issues.

There can be little doubt that the application of technology in the past has eased many threats to the safety and the biological needs of countless people worldwide, but simultaneously many new problems have evolved. These include long-term global threats from the possible greenhouse effect, the possible depletion of the ozone layer, and pollution on land, sea, and in the air. These threats are well-known, but other problems arising from the application of technology also threaten civilization. In some economies there are many unemployed but highly and inappropriately educated people. As a result of advances in medical technology, the population growth in some countries is so high that local economies cannot accommodate all the newcomers. There are also economies in which the application of technology has eased life so much that some people have more leisure than they can handle responsibly.

One unexpected result of the application of modern technology is the growing coolness and sometimes even antipathy toward technology. The vital wealth-creating role of technology is frequently forgotten and only the negative ecological effects are considered. It is all too easy to condemn development in a relatively undisturbed area if one's own tranquillity is disturbed but where one's own job or future job is not at stake. This coolness or antipathy leads to a reluctance among young people to train for careers in science and technology.

This reluctance is enhanced by the fact that many other careers provide better financial rewards and more social status than careers in science and technology. This trend may result in a shortage in the near future of the technicians and scientists who are needed to maintain economic well-being. Possible antisocial

behaviours in jobless people that arise from an economic slump may be so disastrous that civilization itself may be threatened.

Technology has at times come under attack by groups of people who see the application of technology as a means by which certain elites can clandestinely maintain or even enhance a privileged position *vis-à-vis* other groups. Technology used for mechanization can be mentioned here, but examples more relevant to this discussion include the alleged use of discriminatory psychological testing in personnel selection procedures, and the less visible but possibly more pervasive use of job evaluation procedures. A standardized job evaluation procedure is often used to provide the most important input to determine what remuneration should be given for different jobs. The problem is that a job evaluation procedure assigns a financial value to different kinds of job activities according to the value system of the developer(s) of the procedure. Such accusations should be, and fortunately often are, taken seriously by the manufacturers and users of the relevant technology. Manufacturers and especially users must take the responsibility for the social consequences of using technology. They should not be surprised when society holds them accountable for practices that abrogate generally accepted social values of the time.

As an example of the endeavour to create human science technology that will have little or no covert implications, the attempts by responsible test constructors to produce psychological tests that are unbiased with regard to biographical variables such as age, sex, language and ethnicity can be mentioned. A complicating factor is that test bias cannot be empirically investigated outside the framework of a scientific theory or model. Because of ethical restraints on experimenting with human beings, the difficulty,if not impossibility, of obtaining the co-operation of all experimental subjects over a period of time, and the probabilistic nature of human laws, it is more difficult to choose between competing theories and models in the human than in the natural sciences. The very model that is

chosen as a framework for investigating test bias may therefore to a certain extent be determined by the investigator's own bias or world view. Competing theories in the human sciences, with their important consequences for technology, emphasize the need to continue and even to escalate basic research in the human sciences.

It is also instructive to mention a problem where basic scientific research is unlikely to help solve the problem. The value systems underlying job evaluation procedures are intertwined with those that lie on the spectrum typified by the economic systems of socialism at the one extreme and free enterprise at the other. Job evaluation procedures can never therefore be politically neutral. There are reasons why scientific endeavour may find it formidably difficult, if not impossible, to produce objective information which will help to solve the problem of conflicting economic values. These reasons include the following:

(i) The values in question (and therefore also the associated behaviour) may be changed in individuals by education, indoctrination, or intimidation.

(ii) The factors that are involved with changes in values and the possible interaction between these factors are unknown.

(iii) The limits and reversibility of changes in values and associated behaviour are unknown.

Evaluating human science technology

In a letter in a company newspaper, a graphic designer was perturbed by what he thought was the ease with which "people without proper background" criticized the products of graphic designers. In another context the same person described the colour grey as a "dignified" colour and not a "boring" one. What are the criteria by which technology ought to be judged? Subjective criteria such as those used by the graphic designer to evaluate colours will simply not do. Relatively objective criteria

based on measurements of the resultant properties of the technology employed are needed. Because of the complexity of human behaviour, absolute consistency of results will probably never be achieved. Sophisticated statistical sampling and inferential techniques will often be needed to decide how efficiently a given technology achieves its aims. The matter is often further complicated by the considerable time that has to elapse before measurements of the "final" outcome can be made. Although not all technology is founded on sound scientific principles, confidence in a particular technology will also be enhanced if it can be shown that it is logically structured on reasonably well-established scientific principles. Technology structured around a "black box" should always be regarded with suspicion.

The fact that selling human science technology can be financially profitable complicates the task of a practitioner who has to decide between two competing technological products that are supposed to do the same job. Marketing strategies are sometimes designed to conceal the weak points of an instrument. Few people are trained and/or experienced in judging the appropriateness of experimental designs and statistical techniques used in the evaluation of technology. Scientific journals of the social sciences help researchers to evaluate human science technology, but relatively untrained persons in the human sciences, such as managers in corporations or in public agencies often are, have serious difficulty in making informed decisions about what is viable technology or what is a current social fad. Marketers know this and some exploit it in their marketing strategies: they sometimes direct their efforts to selling to managers who have too little relevant technical or professional training to evaluate the technology in question but who are strongly attracted to the purported benefits of implementing the technology. Pressure may then be put on subordinates to use the technology. The subversive effect of mistakes of this nature

sometimes takes a long time to manifest itself and may never be identified as the cause of problems.

It is obvious that the developer of human science technology should be aware of the needs of prospective users. The developer is usually compelled to involve end users in the development of a product. End users have come to expect and legitimately demand quality products, but products are often developed in an iterative process, i.e. a process in which better versions of the product are produced in consecutive stages. However, the users can also legitimately demand that the evaluation of the product should be integrated into its development and that it should be directed at improving as well as producing sufficient scientifically based evidence for the efficiency of the product.

Statistical technology plays a significant role in human sciences technology and supports the whole process of research, from the design of an investigation to its conclusion. It includes the sampling of data, exploratory data analysis, statistical inference and model building, and the final interpretation of results. Statistics help us by providing the rules whereby uncertainties and chance effects in human behaviour can systematically be taken into account when making inferences from data.

Statisticians find themselves in the midst of a revolution in computer technology that favours the growth and development of statistical technology in the different facets of data analysis. The use of software packages as "magic boxes" can, however, be dangerous. Naive acceptance of the assumptions underlying analyses and the even more naive assumption that the data is error free, may lead to decisions with unhappy consequences. The message here is clear: obtain the advice of a competent statistician when vital decisions have to be made on inferences from statistics obtained from complex statistical models.

It is often costly to draw a representative sample from a human target population. It is much cheaper to draw a convenient sample. Experts in the field of sampling are

sometimes dismayed by the statistical naivety shown by managers who have to spend money to obtain information from samples and then choose the cheapest, and often most useless option.

An empirical investigation in the human sciences is usually based on observations obtained from a sample which is drawn from the target population. Information obtained from the sample elements is then generalized by using methods of statistical inference to reach valid conclusions regarding the characteristics of interest in the target population. The findings and conclusions drawn from such a sample survey will only apply to the population from which the sample has been drawn. However, to reach scientifically valid results it is essential that the sample should in all relevant respects be a good approximation of the population, that is, the sample should be representative of the population. Efficient and cost-effective sampling procedures depend on what is known about the population to be sampled. Statisticians have designed a number of sampling procedures (some containing multiple stages) that will optimize the probability of obtaining a representative sample within the constraints of a given budget. All of these sampling procedures involve random sampling at some or other stage.

The impact of human sciences technology

In the 1990s and later, organizations in Southern Africa will be confronted with strategic decisions on how best to revitalize their economic performance. Human, social, and institutional factors will be particularly significant in this process of revitalization.

In studying the social impact of implementing any example of human science technology, one may on the one hand distinguish between who is influenced, individuals or identifiable groups of people, and between what is influenced on the other hand, for instance attitudes, wellbeing, capabilities, interactions and values. An impact study in an organization for instance, after the introduction of a new merit assessment scheme

or a new computer system, could provide management with information to counteract any negative impact or to maximally benefit from any positive impact. Social impact studies could be undertaken by organizations themselves, or could be performed by any suitably qualified organization, such as the HSRC.

While managers are understandably concerned about the economic benefits to be derived from the implementation of technology, the benefits to be derived from the implementation of human sciences technology are not generally appreciated. A few examples will illustrate how important such benefits may be.

Personnel selection and assessment usually involve the use of psychological and/or other tests. This is an excellent example of the implementation of human science technology. A study by Schmidt, Hunter, McKenzie and Muldrow (1979) shows that the widespread use of a valid test to select computer programmers could result in a productivity enhancement worth millions of dollars. Van der Walt (1989) estimated that the elimination of the weakest 10 % of first year students with the aid of a scientifically designed selection battery could result in an annual saving of almost R17,7 million, whereas the cost of developing a suitable selection battery would only be in the region of R100 000.

Ergonomics (the scientific study of the efficiency of man in his working environment) has applications in fields such as aviation and power plant design. Many lives and millions of rands may be at risk when errors arise from the poor readability or interpretability of control gauges. Tornatzky and Solomon (1982) reported that the original design of the F-18 American aircraft prevented pilots from reaching certain controls and performing certain essential tasks. Ergonomic specialists helped to redesign the cockpit. The resulting changes improved the safety of the aircraft and saved the manufacturer millions of dollars.

Survey technology is used extensively to obtain information for government and business organizations on the knowledge, attitudes, needs, behaviourial intentions and behaviour of

prescribed target groups. Tornatzky and Solomon (1982) reported that in the USA in 1978 approximately $4 billion was spent on surveys. The information obtained was used, among other things, for policy making, assessing market potential, and investment decisions.

There is a tendency, even by human scientists, to underestimate the role of human sciences in social change. Some scientists even speculate that inventions in the human sciences may be important causes of social change, and also that they provide the tools needed by society for adapting to change. Modern society has come to depend heavily on the human sciences and its technologies. Without them, desirable social change will be impossible. These arguments may raise the spectre of undesirable social engineering. The only way for society to prevent undesirable social engineering is to use all the means at its disposal to keep democracy alive.

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TECHNOLOGY FOR EDUCATION AND TRAINING

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Introduction

At present, many people undoubtedly regard the field of education and training with a sense of hopelessness, seeing it as a minefield of difficulties. The problems range from macro-level issues such as educational policy, the provision of facilities and services, teacher training and the curriculum, to issues more specifically related to classroom practice, e.g. teaching techniques, subject methodologies, the quality of textbooks and other courseware, and learning difficulties of various types.

The more severe a country's problems pertaining to education, the greater the need for well-researched, dependable procedures and techniques which could bring about some improvement in educational praxis. In fact, introducing new educational technology into the classroom has the added bonus of indirectly enhancing the quality of teaching through providing good examples of praxis which teachers may then apply in other subjects and contexts. Findings by the World Bank concerning educational intervention in the developing world moreover suggest that the provision of educational materials is the most cost-effective way of improving educational quality (World Bank, 1989; cited by Liddell *et al.*, 1990).

In Southern Africa the need for appropriate educational technology in its broadest sense is felt on all levels of formal education, from the preprimary to the tertiary phase. Educational technology is also imperative for basic adult education and non-formal education and training in the job situation.

The improvement of learning and training pertains to far more than media management, educational programme development and learning resources. The applications and impact of educational technology could range across virtually all educational issues — from teaching praxis to the evaluation of courseware, programmes and systems; and from the development and use of high-technology procedures to the macro issues of educational planning and provision.

On 1 October 1990 the Group:Education was officially instituted within the HSRC, marshalling an impressively large and most knowledgeable team of educational researchers. The express aim of the group is to contribute to educational development in the country through research and development, and its vision is to promote the optimalization of education by means of multidisciplinary research and development. The Group:Education is concentrating on four broad areas, namely

- learning and instructional products
- educational assessment
- psychology in education
- educational systems and strategies.

Some of the most important areas of expertise now residing in the Group: Education, are the following:

- developing and evaluating textbooks and courseware for various skills and subjects
- evaluating and adjusting the readability of textbooks for specific grade levels
- identifying potential in pupils
- developing and standardizing tests and aids for learning
- developing item banks and diagnostic tests for languages, the natural sciences and other school subjects
- applying such instruments to improve the standards of education
- compiling and presenting programmes in fields such as career guidance, study methods, sex education and cognitive enrichment
- developing a curriculum, courseware and training strategy for adult basic education
- planning and evaluating education systems and curricula
- gathering and processing educational statistics
- developing educational models
- determining attitudes to particular issues in education

- undertaking macro-research projects in partnership with other stakeholders in education.

In addition to creating a number of specific products the HSRC has over the years accumulated a vast body of knowledge and expertise which could prove invaluable to the country in the design of situation-specific and user-specific materials or procedures, as well as in the evaluation of educational systems and programmes. These products could be developed by the HSRC, or by other institutions using the guidelines as published by the HSRC.

This chapter offers a brief overview of some of the products which are available. It reflects the expertise in educational technology which rests in the HSRC, and will also refer to publications containing guidelines which could be directly utilized in the development of materials or procedures for the unique requirements of any education situation. Attention will firstly be directed to technological development at the classroom or micro-level of education for children and adults, and subsequently to applications of technology at the macro-level of education.

A focus on the classroom

The role of courseware

Textbooks and other educational materials are crucial for effective learning at any level in school or college. This holds true not only in the formal setting of the classroom, but also for independent learning and/or homework tasks in which specific principles and content must be practised or applied.

Courseware must be inviting and must present the content systematically and lucidly, in a way and at a level appropriate to the particular group of learners. Both the language in the text and the didactic approach or methodology governing the explanations are therefore tremendously important.

In South Africa in particular, textbooks and other educational materials are at present under severe criticism for their overall

quality and the level of language usage. Much of the courseware is thought to disregard the special needs which some pupils may have. For example, a large proportion of the pupils are sorely hampered in their efforts to follow lessons because the medium of instruction changes for them in Standard 3 from their mother tongue to one of the official languages (Van Rooyen, 1990). They also lack the language proficiency required to comprehend printed text adequately (Macdonald, 1990b). Problems such as these underscore the importance of devising educational materials locally and with great care.

In the job situation, employers in this country are faced with a mammoth training task at all levels. The field ranges from literacy training and basic adult education to courses in advanced management skills, and furthermore encompasses the interests and activities of entrepreneurs as well as those of established companies. The value that custom-made training models and courseware could have in this sphere, certainly fires the imagination.

This section will first consider the nature of the information that the HSRC has accrued through research, that is proving valuable in materials and course development. Next, some educational products that have already been created by the HSRC will be briefly introduced. The discussion will deal with the preschool and school phases and will cover the issues of cognitive development, instruction and learning, the use of technology for learning and for broader purposes, and educational and psychological tests.

A knowledge base for materials development

Expertise and research findings from a variety of projects and disciplines in the HSRC are currently making an exceptional marriage in the field of educational materials development. Valuable information has already been gathered on issues such as the following:

- the learning needs of various social, population and age groups

- insights concerning curriculum development
- didactic expertise in the various school subjects
- principles for modular instruction
- criteria for the development of worksheets
- learning difficulties of various types and origins
- expected achievement levels per subject
- socio-economic and socio-cultural effects on learning
- language acquisition and language problems in the mother tongue and a second language
- the use of high technology for specific learning tasks, and in specific learning environments
- considerations of educational policy and provision.

Drawing from this store of information and expertise, the HSRC is clearly able to develop courses and courseware to suit the unique requirements of any institution or group in Southern Africa. The preliminary work still required in individual cases would generally be limited to a needs analysis and the formulation of learning objectives for a particular course and target group.

Two products under development could contribute significantly to courseware development in the country, namely the HSRC Text Analyser and a computerized instructional design data base.

In creating and evaluating English educational materials for South Africa, readability in terms of the requirements of second language speakers is increasingly recognized as a crucial criterion. The HSRC Text Analyzer will enable publishers to produce more appropriate materials for a targeted readership at a particular level. It could also be utilized as a clearing mechanism by a department of education when selecting suitable textbooks and prescribing literature.

The data base for the computerized text analyzer comprises a grade level word frequency list derived from a corpus of 1,2 million words from educational materials currently in use in this

country, a receptive vocabulary of lower primary school pupils, and Dale's 769 and 3 000 word lists. The items have further been coded in terms of ten parameters which have a bearing on word complexity in English, such as the degree of phonic regularity, word length, morphological structure, parts of speech, and possible experiential base of acquisition. For each text to be assessed, the client will specify a reading level as well as the limits for each parameter which he wishes to bring into consideration. All words in the text not meeting the specifications will be tagged in a printout of the text for closer editing. Word complexity is of course not the sole criterion of readability and the HSRC will be offering an editing service to complement the analysis with regard to issues of syntax and presentation.

The Computerized Instructional Design Data Base will contain the most reliable and recent findings and information on learning and instructional design, including text design. The most prominent sources and experts in the field have been identified and this body of knowledge will form the core of the data base. To computerize the information a commercially available utility package will be used. The data base contains 17 core fields, each allowing for more specific levels of articulation that enables the user to define information needs very specifically. The first five fields cater for the instructional design keywords. The following twelve allow for specification of a particular target group, the subject area, the particular instructional medium/media, the instructional mode, the findings and the sources to substantiate findings. The data base will be utilized for consultancy purposes to provide training in instructional design and might ultimately be marketed commercially.

The HSRC has already created a number of educational products catering for general needs. Feedback on their use also constantly broadens the existing knowledge base for future courseware development.

HSRC courseware

The preschool phase

There has been growing concern about the high failure rate among African school beginners, especially in the junior primary school phase. Recent statistics suggest that 24 % of South Africa's preschool children are likely to fail their first year of formal schooling (Schwartz, 1990; cited in Liddell *et al.*, 1990).

The reasons for African pupils' scholastic difficulties have been researched from a number of perspectives, the latest including socio-cognitive development in the preschool phase (Liddell *et al.*), and language-related issues (Macdonald, 1990a; Kroes, 1987; HSRC, 1986). The data derived from this research is proving invaluable in conceptualizing and refining learning aids which could effectively supplement the learning experiences of African children in terms of general school readiness and language acquisition, especially where learning must take place in the medium of a second language.

The vast number of African toddlers and preschoolers who attend crèches and childminding establishments while their parents are at work, has been identified as a group of children in special need of exposure to enriched learning experiences. The HSRC was contracted to put together a stock of toys which could be widely distributed at a low cost, to cater specifically for their developmental needs. This brief resulted in the creation of the Coke Toybox, containing sufficient activities for six to 15 children, aged between two and four years, at an average cost of a mere R37 per child. This toybox is indeed transforming many drab and impoverished childminding settings into bright and busy educational centres.

An extensive baseline study was conducted to ensure that the toybox would really suit the conditions for which it was being designed. In addition to psychometric tests, the study involved direct observations of the children at play in the childminding establishments, covering a range of developmental features of their play and measuring their spontaneous levels of competence

during play (Liddell *et al.*, 1990). The following areas were analyzed:

- patterns of language use in play
- patterns of social interaction in play
- types of activities children engage in during free play
- levels of play with objects
- patterns of cognitive engrossment and attention span.

After the introduction of the toybox into crèches and childminding establishments, a similar set of data was collected to assess the efficacy of the materials, and further improvements are duly being attended to.

The activities provided by the enrichment materials in the toybox are intended to stimulate the children in 13 different areas of social/psychological/educational competence. These are:

- eye-hand coordination
- co-operative learning
- shape recognition and naming
- spatial concept recognition and naming
- creativity
- attention span development
- vocabulary development
- letter recognition
- number recognition
- colour recognition

] not stressed for two to four-year-olds, who are still rather young for these skills.

- left-to-right logical sequencing
- problem-solving competence
- gross muscle development.

Specific criteria were adhered to in selecting and developing the materials, namely:

- indigenous relevance
- promotion of self-discovery
- high proportion of local content
- multicultural contexts.

Most of the articles are produced locally, providing valuable job opportunities for a number of people.

Following the established principles and utilizing the data collected during this enterprise, toyboxes could now be designed to meet other unique sets of requirements. The endeavour could also be extended most fruitfully to home enrichment schemes and book schemes for use in a variety of settings.

The school phase

A comprehensive analysis of the activities and interactions of African preschoolers undertaken by the HSRC has demonstrated that their development conforms to the norms of socio-cognitive development established in similar research for western communities (Liddell *et al.*, in press). Consequently, the difficulties experienced by African pupils at school cannot be ascribed solely to environmental and/or developmental factors.

The findings seem to point to deficits in the school situation itself, thus emphasizing the need for better educational provision and the upgrading of teaching skills. This opens a dramatic new field for the creation of innovative educational procedures and materials in the junior primary phase. Such a course of action would be a hopeful one, in that a solution which utilizes materials and teaching procedures is obviously more feasible and promises more immediate results than one which has to depend on changes in the actual circumstances, activities and/or culturally determined interactions of the children and their parents.

In all school phases, language difficulties have been identified as a crucial factor in the performance problems of African pupils. One of the projects which specifically addressed this question was the Threshold Project (Macdonald, 1990a).

The primary problem which the Threshold Project looked at, was the nature of the language and learning difficulties that Std 3 African children experience when they change from their mother tongue to English as the medium of instruction and learning.

The research aimed to describe the nature and extent of the linguistic abilities of African children in Std 2 — 3 and also the nature of the children's reasoning skills, in order to enhance an understanding of their performance on school learning tasks.

The Threshold Project also examined the disparity between what is expected of children in Std 2 in English as a subject (English as a second language) and what is expected of the children when they start to use English as the medium of instruction.

Careful observation of the children's school-based learning experiences gave rise to insights about how these experiences can help or hinder learners. As an outcome of the research, it was possible to formulate principles which are intended to assist and inform curriculum developers.

Since the completion of the six major reports of the Threshold Project, the work has moved into new directions. In order to share the information acquired during the course of the Threshold Project as widely as possible, a book for a lay readership has been written (Macdonald & Burroughs, 1991). This will form part of a larger dissemination process which will involve visiting groups and institutions who have a stake in the future of education in South Africa. The aim of this process will be as much to learn as to share what has been learned.

In order to use the insights and findings of the research, an English course, starting from Grade 1 and extending right up into the senior primary levels, is being written. The new course enables children to slot into English as a medium of instruction at any point from Std 1. The course is task-centered, starts with child-centered concerns and rapidly moves outwards to deal with maths, general science and geography topics. These topics are dealt with in such a way that they will support the formal introduction of separate subjects at the Std 2/3 level.

Although it will primarily be for second language learners, much of the course may well be suited to the learning needs of first-language children too. The course takes into account what

was learned about the need to transform the learning-teaching process. Likewise, it has, as a basic premise, the need to actively develop the cognitive skills required later by what is generally termed the content subjects. These are two of the informing principles gained from the research.

This work, undertaken in conjunction with a major publisher, is intended as part of a larger drive which recognizes the urgency of developing outstanding learning materials in the indigenous languages of South Africa as well. The importance of this perspective once again derives from the insights gained during the research, which highlighted the interrelationship of the development of children's first and second languages.

As part of an on-going educational programme, the Threshold Project also offers a workshop on text-analysis and evaluation, aimed to inform publishers and other people involved with the selection of reading materials for newly literate readers.

On a number of occasions recently the Threshold Project has been asked to advise on the suitability of learning materials in the light of what has been learned. It is hoped that this kind of service may help to raise general awareness about the criteria which make for excellence in learning materials.

The data could obviously be put to further use in devising textbooks on all subjects which would be sensitive to the needs of second language learners, to match their standards of language and reading proficiency and the cognitive skills levels at which they actually function. In the Threshold Project, a highly successful experimental development and implementation of a module of science education materials for Std 3 was also undertaken. This work not only paved the way methodologically for similar endeavours, but also confirmed the value of materials which provide learners with greater support.

Another set of HSRC projects addressing language problems in learning, concentrates on reading. Preliminary research for a comprehensive supplementary reading course for senior

primary pupils in African schools, also undertaken in conjunction with a publisher, yielded the following baseline information (Bouwer, 1990a & 1991):

- a needs and situation analysis of English reading in African schools
- guidelines for developing a supplementary English reading course, aimed at promoting independent performance at a sufficiently advanced level to enhance learning, and in a format which would be specifically suited to the teaching and learning needs connected with reading in a second language
- a qualitative evaluation of the reading skills of African pupils in Standards 2 — 5
- an analysis of the question taking skills of African pupils in Std 2 — 5, in reading-related tasks
- a teacher and pupil interest inventory, suggesting content themes and modes of presentation which would have special appeal for senior primary African pupils.

Based on the insights gleaned from the research, the supplementary reading course is being carefully graded to systematically teach the essential question taking skills through various question formats, while at the same time gradually raising the level of linguistic and content complexity. The course specifically aims at developing the skills of independent reading, to enable pupils to read materials of various types and to transfer skills learnt in the reading course to their other reading activities.

The early levels of the course are also expected to fill the sorely felt need for more reading materials for new literates. The more advanced levels of the course could again prove useful for bridging into integrated schools and to improve reading skills upon entering the secondary and tertiary levels of education.

High technology in education

A support for learning

The acute shortage of teachers who are adequately qualified to educate the vast numbers of children in Southern Africa, has

already been noted. Although the final solution to the problem obviously lies in improved teacher training and recruitment, other measures must be considered in the short term. High technology is popularly thought to be a viable option, especially in view of the ever-increasing stock of good courseware and programmes becoming available.

However, the technical equipment for education has no magical powers which could at the push of a button automatically bring about mastery of academic skills and knowledge. Selecting and utilizing such teaching and learning aids effectively, require special skills. Courseware design in itself also poses special demands. One area which the HSRC has investigated profoundly, is computer-assisted reading instruction and remediation.

Proponents of the meaning-based view of reading tend to regard the idea of technology-assisted reading instruction with suspicion, expecting an undue concentration on controlled reading activities. Attention to what is termed the splinter skills of letter and word recognition is often dismissed as a reflection of outdated reading instruction theory, which would presumably fail to accord the actual comprehension of text its rightful value. The problem has long been compounded by the fact that few good curriculum designers became involved in the development of reading courses for the computer (Balajthy, 1988), so that much of what is available on the market meets with express disapproval from the discerning teacher.

However, computer courseware for reading instruction has lately demonstrated marked improvement in design, as both the technology and the creative ideas for harnessing its potential for interactive learning have developed apace. Users can now afford to become increasingly critical of the programmes on offer. Excellent results may be expected if teachers follow an interactive model of language and reading instruction in their applications of the software.

A model for computer-assisted reading instruction only qualifies as interactive if learners are actively engaged in monitoring their performance in word recognition and textual comprehension in a meaning-based, individualized and integrated manner. The computer obviously cannot be substituted for authentic book materials. Yet, used wisely, it could prove invaluable to the development of the learner's decoding and comprehension skills, especially if the courseware provides liberal feedback and includes activities which require a substantial amount of reading on screen and from books.

The feedback with regard to incorrect responses is especially important, as pupils can learn a great deal from their errors. Not only must the readers' understanding of the particular issue be enhanced (e.g. in terms of word knowledge), but so must their reading strategies and cognitive skills in general. Meaning-based options worth considering are explanatory remarks about the particular error, or the technique of textual reference (i.e. calling up the paragraph which contains the relevant information for re-inspection, with or without emphasis on the exact sentence).

Detailed research by the HSRC on computer-assisted reading instruction has recently culminated in an instructional model of great sophistication, as well as a report on *criteria for the design and selection of courseware* for computer-based reading instruction (Du Plessis & Bouwer, 1990). In addition to the impact that it has had on courseware design within the HSRC itself, the report also has wider relevance for programme developers and teachers of reading.

Crucial factors in the new design mainly concern the following:

- the communicative use of the texts
- the ways in which various screen display modes are implemented to increase reading fluency
- the activity and question formats selected
- the particular questions which are set
- the feedback provided in case of errors.

The model represents a synthesis of the top-down and bottom-up models of reading instruction, thus allowing for a meaning-based approach to reading via content, as well as giving direct attention to word recognition skills. The material is carefully graded in terms of word structure, syntax, expression and content.

The computer facilities which are utilized in various combinations and forms, include the following:

- various dynamic screen display modes for the reading of prose text against a time limit, e.g. per line with paced erasure from behind, per line progressively moving down the screen in simulation of a page of print, and on full screen
- the tachistoscopic display mode, for flash exercises to practise skills such as letter and word recognition, sound blending, and word discrimination
- the timing facility, useful in measuring performance and motivating the learner through self-challenge and visible progress
- a speech card, to be used, *inter alia*, for the self-checking of pronunciation, spelling and verbal response exercises
- the creation of graphics, particularly valuable in supporting vocabulary development and enhancing the appeal of the lessons
- facilities for manipulating text on screen, e.g. moving text, invaluable in sequencing exercises, e.g. for chronological and logical relationships and prioritizing
- highlighting items, especially useful for emphasis during selection procedures and as a feedback device for incorrect responses
- altering and/or inserting items, in editing and Cloze tasks
- the facility for unlimited repetition of items (any number and format) in random or regular order, for drill-and-practice exercises
- the branching procedure, allowing for options of remedial/increased work per topic, skipping tasks,

providing feedback, or even changing/escaping from speed settings or activity formats.

Four sets of courseware for computer-assisted reading instruction which adhere to the new model have already been produced in Afrikaans and an extensive English programme with parallel strands for first and second language speakers is being developed.

In the Afrikaans courseware (dubbed "LEESPRET"), the reading levels overlap somewhat among sets, to accommodate specific learning needs across a wide age range. Material for individual children can thus be selected in a highly flexible manner for the double criterion of reading level and specific learning requirements.

The aim of flexibility has been accommodated differently in the English reading development course. "World of Words" (Wow! for short!) has a rich workbook base to provide the variety of teachers' and learners' needs. Each chapter contains three texts related to a central theme, namely a story, a factual text and a poem, each with an extensive range of vocabulary and comprehension exercises. At the junior level a fourth section, "Something interesting to do", contains activities related to the theme — the rationale being that young readers should be offered the opportunity to apply their reading in real action. The narrative text further provides the base for the computer exercises.

The overall design is a good example of multipurpose courseware, adaptable for use in more than one situation. The book materials accompanying the computer programmes are inexpensive and may be used separately by teachers and therapists, i.e. for the conventional modes of reading instruction and remediation. In this way the reality of the economic constraints on materials development and educational facilities in South Africa has been accommodated, while yet making advanced technology available to those who have the means to utilize it.

A similar approach has been adopted in creating a detailed self-help course in Afrikaans for secondary school pupils in study techniques and critical reading. This course, "Weet en Wen", aims at simultaneously developing advanced reading skills and effective study skills. Once again it finds its highest application in a computer-assisted version. Lessons integrate instruction in enhanced reading fluency, comprehension skills and appropriate reading strategies for various purposes, by applying the principles in studies of factual content, requiring the extraction and structuring of relevant information.

Following the same model, custom-made courseware dealing with particular themes and vocabulary items and accommodating the specific reading needs of the target group, could be produced for any company or institution. High technology support in literacy training is, for example, an enterprise deserving special consideration. A computer-assisted reading course in adult basic education will not only allow unlimited repetition and all the advantages of interactive sound and speed work to enhance letter and word recognition for late beginners at a relatively low cost, but will also ensure a consistently high quality of instruction, irrespective of the language teaching expertise of the trainer. Through individualized instruction and record-keeping procedures, it will ensure continuity by compensating for the high rate of absenteeism among literacy learners.

A general application

A further area of computer application by the HSRC is that of career guidance. A computer-assisted career guidance system, MENTOR, has recently been developed exclusively for South African conditions. In view of the shortage of competent career counsellors in the country, the MENTOR system addresses the need for readily available relevant information for effective and individualized counselling to several people simultaneously. MENTOR could render valuable assistance to high school pupils, currently totalling more than 100 000, students at tertiary

institutions who are still unsure about their professional careers or who require information about financial support for their studies or about job opportunities, and also young adults experiencing career uncertainty. The system has made it possible for any individual to work through a well-planned career development programme when the need arises.

The computer can store an immense amount of information on occupations and educational and training opportunities. This information can be quickly and easily retrieved, and can be easily updated. The information can also be presented objectively. Carrying out search strategies is one of the best capabilities of the computer. The user can stipulate one or more criteria, whereupon the computer will produce a list of occupations matching the criteria. A variety of options can thus be explored with ease simply by changing the criteria.

One of the principles of career development is that the career counsellor must be aware of the career development stage of the client, the career development tasks in which the latter should currently be engaged, and how well the client is dealing with those developmental tasks (Super, 1963).

The HSRC MENTOR system focuses on the career development stage of exploration. This coincides with the adolescent and early adult years, i.e. the period when most individuals choose and enter an occupation for the first time (Holland, 1973). Vocational developmental tasks applicable to the exploration stage are the following:

- self-awareness (of one's abilities and limitations)
- the ability to make responsible decisions
- awareness of resources in career exploration
- the ability to relate self-knowledge to occupational information
- the ability to plan a career.

The HSRC MENTOR system is based on the assumption that certain systematic interventions can foster and streamline the process of career development. With the above career

developmental tasks in mind, the following components of a systematic computerized career guidance programme were drawn up:

- self-concept clarification
- translation of self-concept into occupational terms
- broad and systematic exploration of occupations
- teaching of decision-making skills
- reality testing and information collection about tentative choices
- making choices
- implementing choices.

These components were then translated into parts or modules of the MENTOR system. Each section can be entered directly and used independently of the other sections. Printouts can be made of any screen.

When the user elects to make a list of occupations to explore, several search strategies are presented, for example using the results of the Values Scale or the South African Vocational Interest Inventory (Du Toit, 1991), school subjects, level of education, starting salary, and job characteristics.

Detailed information on occupations is presented in the form of answers to six questions, which entail the following:

- the nature of the work, the tools/equipment used and the work setting
- the personal requirements, advantages and disadvantages of the occupation in question
- the school subjects, school level and educational/training requirements, as well as possible ways of obtaining training for the occupation
- employers, areas of specialization and related occupations
- the salary range, opportunities for advancement and future prospects
- additional sources of information on the occupation.

MENTOR also provides general information on different types of tertiary education/training, including the addresses of the various institutions and the courses offered at each. The user can also view the courses relating to a particular occupation at any number of institutions.

Each user signs onto the system with a unique code. The system keeps a record of the results of any assessment instruments which the user completes, the list of occupations currently under consideration, and the parts of the system that have been worked through. In this way the experience is personalized for the user, who feels in control not only of the system, but also of his/her career planning.

Educational tests

In all contexts of education and training, the evaluation of the learners' progress forms an integral part of instruction. Test results provide information by which to assess the standard of the instruction and make decisions about the learners' promotion. Without testing, instruction could become superficial and lose much of its intrinsic motivation.

Initial evaluation has been recognized as especially helpful in enhancing the quality of instruction. Assessing the learners' standard of performance at the beginning of an academic year or a particular course indicates the level at which the instruction should commence. It may furthermore indicate relevant learning objectives, by revealing the content and the level of subject-specific skills that the class could safely be expected to master.

Test results also identify those pupils in the class who may require special attention on account of a learning difficulty. Learning difficulties of varying degrees and duration occur in every classroom. All teachers have the responsibility to deal with the problems of pupils who perform poorly. If timeously identified, learning problems can often be solved by remedial teaching within the school. To this end, a careful assessment of

the pupil's performance levels by means of diagnostic testing is essential, to decide upon the most sensible course of intervention.

Class tests and internal school examinations are undeniably important, but this form of testing rarely meets the demands of complete reliability, validity and objectivity. The standard of testing by different teachers and in different schools may vary considerably, and may thus not accurately reflect the learners' performance. This could account for the dramatic drop in the grades of some pupils when they change schools, and is also the reason why standardized tests are required for all the purposes of assessment described above. A standardized test has scientifically normed scales, derived from the performance data of a randomly selected sample of pupils who resemble the target group with regard to all relevant characteristics. Most questions in standardized tests have multiple-choice responses.

A multiple-choice item is a question consisting of a stem (where the question is asked or the problem posed) and a number of options consisting of the key, or correct option, and three distracters (incorrect options) which are clearly wrong to informed testees but attractive to ill-informed testees. Multiple-choice items are extremely flexible and can be used to test an extensive variety of human characteristics, including cognitive outcomes such as knowledge and the ability to think and make judgements. They admittedly do not directly measure the pupil's ability to plan and formulate an extended piece of writing, although many of the underlying skills and thought processes can be measured in this way.

It has never been the point of view of the HSRC that multiple-choice questions should replace all traditional methods of testing. The extensive use of multiple-choice questions is however advocated, as in many ways and contexts it undoubtedly represents a technological advance over the traditional methods of testing. It is a considered mix of the kinds of measurement and is thought to be the most appropriate solution to many problems in educational evaluation.

Obviously no single test could address all the functions of evaluation. The type of instrument must vary according to the purpose of assessment. For small-scale and individual evaluation in the classroom, the options range through achievement tests, proficiency tests and diagnostic tests. The purposes of general examinations are chiefly catered for by the item banks.

Achievement tests

Achievement tests measure the results of instruction and learning at school. The items cover the syllabus content and assess the pupils' knowledge and insight with regard to the specific content and skills which they may be expected to have mastered. The test results also reflect the pupils' degree of readiness for particular content, and predict the measure of the future success that they may hope to achieve in the subject (Owen & Taljaard, 1989). Initial evaluation tests, based on the syllabus of the previous year, have therefore developed as a special form of achievement testing.

The following scholastic achievement tests standardized by the HSRC are currently in use:

- English First Language, Grade ii/Sub B — Std 9
- Oral Achievement Tests in African Languages (Third Language) Std 5
- English Second Language, Std 1 — 9
- Standardized Achievement Test in Afrikaans First Language, Grade ii/Sub B —Std 9
- Spelling: Afrikaans First Language, Std 3 —5
- Afrikaans First Language Group Reading Tests, Grade 2/Sub B —Std 4
- Afrikaans First Language, Grade ii/Sub B —Std 9
- Afrikaans Second Language, Std 5, 7, 8 and 9
- Afrikaans Listening Comprehension, Std 5 and 8
- Afrikaans Group Spelling Test, Grade i/Sub A
- Listening Comprehension Tests in African Languages

- Initial Evaluation Test in Afrikaans, Std 2 — 5 and 8 (for DET*)
- (Third Language) Std 5 and 6
- Initial Evaluation Test in English, Std 2 — 5 and 8 (for DET*)
- Mathematics, Std 5 — 7
- Mathematics (Seniors)
- Initial Evaluation Test in Mathematics, Std 1 — 10
- Mathematics, Grade i/Sub A — Std 4
- General Science, Std 5 and 7
- General Science, Std 9 and 10
- Physical Science, Std 5,7, 8HG, 9 and 10
- Algebra, Geometry and Trigonometry, Std 9 and 10
- Geography, Std 5
- History, Std 5
- Economics, Std 10HG
- Academic Achievement Test for first year students
- Literacy Tests in English Second and Afrikaans First Language
- Biology, Std 7,9, and 10 .

* *Department of Education and Training*

Proficiency tests

Proficiency in a particular field of study or knowledge is defined as the level of knowledge, insight and skill that a person has reached in that field as a result of his learning opportunities, experience, aptitudes, interests and motivation. Proficiency tests address the broad educational background pertaining to a subject, rather than the content delimited specifically by the syllabus (Owen & Taljaard, 1989).

The following proficiency tests standardized by the HSRC are currently available:

- Standardized Proficiency Tests —Intermediate level. English Second Language
- Standardized Proficiency Tests —Advanced Level. English Second Language

- Test of Basic Literacy in the main Sotho and Nguni Languages
- Listening Comprehension Tests in African Languages (Third Language), Std 5

Diagnostic tests.

A diagnostic test is primarily concerned with analysis and not with measurement. The objective is not to compare a particular pupil's achievement with that of other pupils in the same grade or age group in terms of a test score. The chief intent of diagnostic tests is to sound out the pupil's mode and level of functioning in a particular subject, by noting the pupil's application of each of the various skills required and taught in that subject, and identifying the points of breakdown in terms of the specific context, problem/task type and level of complexity involved (Bouwer, 1990b).

- Afrikaans First Language Gr. 2/Sub B — Std 9

The rationale for a diagnostic test design could be said to resemble a check list, in that all the specific learning skills operating in mastering the various activities or content units in the subject concerned, are represented in a graded construction of subject-relevant tasks. The rationale for each task is formulated in terms of the cognitive skills and learning behaviour required for its execution. In interpreting the results of a diagnostic test, this information serves as a framework for understanding the pupil's style of cognitive functioning, as well as a guideline in devising an intervention strategy.

Interpreting a diagnostic test requires an in-depth knowledge of the skills and content of the particular subject, in order to correctly infer the possible range of cognitive implications from the pupil's responses and test behaviour. Equal emphasis must be given to the pupil's correct responses and errors, to compose a complete picture of the strengths and weaknesses underlying the performance.

The diagnostic tests standardized by the HSRC and presently in use, are:

- South African Written Language Test (Afr. & Eng., Gr.ii — Std 5)
- Test for Oral Language Production (Afr. & Eng., 4 y 6 m — 10 y 5 m)
- Mathematics Tests, Diagnostic, Primary Level (Std. 1 — 5)
- Diagnostic Achievement Tests in Basic Algebraic Concepts, Principles and Skills (Std 7 — 10)
- Diagnostic Achievement Tests in Basic Geometry (Std 6 — 10)
- Diagnostic Achievement Tests in Mathematical Language (Std 6 — 10)
- Diagnostic Tests in Basic Algebra (Std 7 — 8)
- Test for Auditory Figure-Ground Discrimination (5-10 years)
- Group tests and individual tests for Afrikaans reading (Gr. ii — Std 4).

Item banks

An item bank is a collection of items (test questions) with known empirical properties — at least their difficulty and discriminating power — in relation to some defined reference group such as the pupils at a given level (e.g. Std 5 pupils) of a particular education department. As in the three types of tests already described, most questions in the item banks also have multiple-choice responses.

It could safely be said that no traditional examination paper is subjected to such rigorous refinement before it is used in a final examination, as are the items contained in the National Item Banks. The fairness of the items is further assured by the fact that pupils themselves help to determine their acceptability.

The items are written by teachers who are aware of the typical level of attainment of pupils at the particular educational level and have been trained in the art of item writing. Great care is taken to ensure that item bank tests cover the syllabus adequately. In all the subjects involved a specification table has been developed that not only specifies the relevant content, but also the relevant cognitive skills. Once written, the items are submitted to the members of an editing committee, who

establish whether they are in agreement on the correct answer. Each item is edited according to the consensus reached by the committee. Clearly, writing good items is not a one-man job.

The items are then placed in experimental tests that are applied to a nationwide sample of about 500 pupils. Item analysis is subsequently performed on the data obtained in this way, in order to select the successful items. The prime requirement is that pupils with greater knowledge or insight (i.e. those whose average mark is higher than the general average on the test) should tend to choose the correct option and those with less knowledge or insight should tend to choose the distracters.

A question that has received much attention overseas, is whether tests consisting of multiple-choice questions are biased against different groups. Test bias can be defined as a characteristic of a test to erroneously predict lower future performance on a criterion than is accurate for a particular subgroup, although this does not mean that a test is necessarily biased if it consistently indicates lower scores for one group than for another. It is actually possible for any test to embody cultural bias. Without going into all the technicalities of test bias, the following can be stated about the tests drawn from the National Item Banks:

- Any test drawn for use by an examining body is subject to scrutiny by persons from that body who are responsible for examining the subject. They are expected *inter alia* to ensure that no questions are asked that would be unfair to the pupils concerned.
- Where pupils are taking the examination in a language other than their home language, it has been found that being relieved of the necessity to formulate extended answers in the second language does make the task somewhat more manageable for them, as reading is easier than writing. A fairer prediction of their ability in non-language subjects can thus be obtained.

- The fact that items are pretested gives a degree of control over the properties of tests drawn from the item bank that cannot be equalled by any other means.

Other advantages of multiple-choice item bank tests include the following:

- Test reliability is greatly enhanced. One of the best-established facts about multiple-choice tests is that with less examination time they produce far more reliable test scores than traditional examinations do.
- Examination time is used most efficiently. When answering multiple-choice questions, the examinees use their time to read, think, decide and to make a little mark on an answer sheet. In traditional examinations they spend their time reading, thinking and then writing a lengthy answer. The latter is a time-consuming, laborious process which severely limits the number of questions that can be answered.
- The principle is adaptable to new demands. Should there be an urgent need for multiple-choice tests in a subject where there is no item bank, it is possible to use the examination situation itself to refine the items. After having scored the answer sheets, an item analysis program can be run and all items that do not function satisfactorily can be eliminated.
- Item bank tests are economical to use. When large numbers of pupils have to be tested, multiple-choice questions prove their economy. The cost of machine scoring is a little more than R1,00 per paper. This is far less than the cost of marking a traditional examination paper. In addition the results are then already on computer, whereas a further step is required to achieve this with traditional examinations. In terms of the whole of South Africa with about 400 000 matriculants each writing six subjects, it could mean a saving of at least R4 800 000, even before excluding the saving effected by reducing to one the number of examination papers in each subject.

One stringent requirement for the successful use of multiple-choice tests under examination conditions is the maintenance of strict supervision. Unauthorized persons in the

examination room can easily divulge answers to examinees and it is also possible for examinees to use predetermined hand signals. However, a programme exists whereby one can determine the level of probability that one candidate's answers have been copied by another.

At present the item banks consist of 500 to 1 000 items per subject and embrace the following subjects in Stds 5,6,7,8 and 10:

- English First Language
- English Second Language
- Afrikaans First Language
- Afrikaans Second Language
- German Third Language
- Mathematics
- Physics and Chemistry
- Biology
- History
- Geography
- Accounting
- Economics
- Business Economics.

The empirical properties of the items are presently expressed in terms of statistics obtained on the basis of classical test theory (termed a "soft" true-score theory). This implies *inter alia* that the data on each item must be interpreted relative to the reference group on which the items were applied experimentally. In the near future the HSRC hopes to bring about significant improvements to the empirical data on the items in the item banks. All old data will firstly be recomputed using the methods related to item response theory (termed a "hard" true-score theory). Where feasible, a second step will be executed by means of an experimental application with appropriate repetition of the same items at different levels, to link all the items in a particular subject from Std 5 to 10 on a common scale.

Item bank tests can be used in examinations in two ways:

- As part of the examination. The tests can be used to enhance the reliability, validity and economy of traditional examinations by constituting a suitable proportion of a traditional examination paper. This could reduce the number of papers set in a particular subject.
- As a moderating instrument. Item bank tests can be the only external test used in each subject to grade the internal marks of each school on a common scale.

Psychological tests

The quality of education for each learner can be considerably enhanced by the wise application of information derived from psychological tests. A psychological test is intended to measure (evaluate) specified aspects of an individual's personality and/or cognitive ability. This additional information may for instance be used to advise parents and teachers on issues such as:

- sending a child to school or not, before the child has reached compulsory schoolgoing age
- the type of secondary school individual pupils should preferably attend, and the curriculum which would probably help them realize their full potential
- factors possibly related to a pupil's poor performance
- factors possibly related to a pupil's problem behaviour
- remedial programmes for a pupil with learning problems
- placing a pupil in a special education programme
- suitable choices for tertiary education and/or other career preparations.

The psychologist has to assume the ultimate professional responsibility for using a test appropriate to the particular circumstances. Test publishers in turn have the obligation to provide relevant and accurate information about the reliability and validity of the tests that they publish, and the steps that were taken to eliminate test bias with regard to variables such as gender, language and socio-economic status.

A wide spectrum of psychological tests that have been specially constructed for use in educational settings, are often also of value in organizational settings. Information on these is available in the regularly updated HSRC Test Catalogue. The following types of tests are available:

- Aptitude tests
- Intelligence tests
- Personality questionnaires
- Interest questionnaires
- Proficiency tests in the official languages and mathematics.

Computers can receive, manipulate and deliver certain kinds of information much faster than humans and it is therefore no surprise to find that computers are already used on a world-wide scale to administer psychological and educational tests.

The HSRC has developed user-friendly personal computer systems which enable one to compile test programmes from a large available set of computerized tests. The system that was developed in the Education Group is called SIEGMUND, while the PsiTest was developed in the Human Resources Group. The testee is registered on the computer, and any one of the precompiled test programmes can then be assigned to him/her. Thereafter all the tests in the battery can be administered by computer with no or minimal intervention from a supervisor. Completed tests will be scored automatically and norm transformation will be performed according to the specifications programmed upon registering. The test user may also change the choice of norm tables at any later stage. A profile of test results can be displayed and/or printed. If desired, the profile can be compared with any one of a number of standard profiles specified beforehand.

The advantages of using SIEGMUND or PsiTest are such that no highly paid professional person having to administer and score tests on a regular basis, can afford to bypass such a system. Test responses are recorded very accurately. The time expenditure of professionals can be reduced to an absolute

minimum, since test administration can be supervised by lesser trained people and scoring and norm transformation will be done accurately, automatically and virtually instantaneously.

Adult education

There is a rapidly-growing awareness of the importance of adult education, both for the growth of the individual and the economy. Companies and trade-unions, as well as literacy organizations themselves, are looking for effective ways of dealing with the many difficulties and challenges involved in offering adults another chance to gain a basic education. The need for responsible answers to questions about literacy and adult education has given rise to the formation of an adult education division.

The adult education division began their involvement in the field by assisting with the evaluation of existing literacy programmes for a number of companies. While evaluation work continues to come in, other areas of interest are also being explored: what the competencies are which would make up an adult basic education; what role the learners' own language should play in the acquisition of a basic education and what the optimal role for English is in the process. Research — being done in conjunction with NEPI — is focusing on the nature of adult basic curricula.

Other issues which are regarded as crucial to the future of adult education in the country are the processes required to create a cadre of suitably trained teacher-facilitators. The critical shortage of people who can train future teacher-facilitators for adults inevitably means that some form of provision needs to be developed to train the people teaching future teacher-facilitators. The adult education division sees provision at both these levels as vital to a serious commitment to adult education in South Africa and is looking for constructive ways to contribute to their development.

Applications of educational technology on the macro-level

Data bases

In education, numerous issues of policy, planning, provision and research depend directly on accurate and up-to-date information on the number of pupils and teachers involved in the particular issue. Education statistics are vital to the determination of trends, the forecasting of educational statistics, and random sampling.

The HSRC plans and develops comprehensive data bases of education statistics in a centralized format which allows information to be retrieved as required. School statistics become available in April following the particular year, and the record of academic qualifications conferred by South African universities slightly later.

By centralizing the information from the various education departments, uniformity of information is achieved. The format is also immediately available for comparative studies. Other data bases in the country are decentralized and the user is responsible for collecting information from different institutions and converting this information to a uniform format. In the HSRC data base the records of each educational institution moreover contain the magisterial district codes, facilitating the supply of information according to development areas.

Besides planning, developing and updating data bases for clients, the HSRC also retrieves, analyzes and/or tabulates data to meet clients' specific requirements. Publications are compiled to order. Enquiries about education and population statistics from both the private and public sectors are dealt with. Clients are advised on the interpretation of data and on the matters that should be taken into consideration in requests for educational statistics. Finally the names and addresses of educational institutions can be made available on labels for educational use.

Unfortunately not all the information in the data bases is readily available. Permission to release information for any purpose other than educational must be obtained from the various education departments.

The design and evaluation of education systems

Sound educational planning and curriculum development depend largely on the quality of the situation analysis conducted. This is a complex scientific exercise since education is closely related to the economic, social, manpower and political issues of a country and it is impossible to evaluate education in isolation from these considerations (Nieuwenhuis *et al.*, 1991). In designing and evaluating an education system the unique development needs, the aspirations of the people and the constraints on development, such as the lack of natural resources and land, must also be taken into account. An education system is therefore viewed as part of a total complex of variables.

The aim in education systems development is to provide pragmatic recommendations with regard to the specific situation, for strategies to develop an education system which would satisfy the needs of the client. Guidelines are then provided for the development of the system, and priorities are determined for its implementation. In developing an education system, a multidisciplinary approach is adopted and further combined with various system-planning strategies.

Considerations such as the following are duly accommodated:

- all educational legislation and the principles on which the laws are based
- the execution of the said laws and principles, in terms of providing education and training at all levels (formal, non-formal, and informal; basic and post-basic)
- financing
- management.

The HSRC has accumulated an impressive body of knowledge on the evaluation and development of education systems and curriculum development through projects related to the development of a national training strategy (NTB/HSRC, 1991), the evaluation of the education systems of departments of education (Nieuwenhuis *et al.*, 1991), and the evaluation of

specific programmes and curricula (Van der Merwe *et al.*, 1991). The infrastructure and skill have been developed to undertake this type of research and development work for clients in the formal and non-formal education field.

The evaluation of educational certificates

The HSRC evaluates South African and overseas certificates in accordance with the HSRC Act (Act No. 23 of 1968). Evaluations are performed at the request of employers, employees, prospective students and other persons or institutions who need this information for appointing individuals or admitting them to training institutions.

At present more than 6 000 applications are dealt with each year. These include certificates issued almost anywhere in the world — from the United States of America in the west, to Hong Kong in the east; and from Scandinavia in the north, to the Seychelles in the south. A network of co-workers overseas has been established to handle the large number of evaluations.

Approximately 50 % of all requests for evaluation are submitted by employers. At present a large number of evaluations are performed for Namibia — for persons who have obtained certificates in other countries as exiles and who have recently returned to the country. This may also happen in South Africa once exiles begin to return. Certificates obtained in non-formal education in South Africa are also evaluated. In the absence of an accrediting body, this service is in great demand. Courses on offer in non-formal education are also evaluated with the aim of determining the status of these courses.

Evaluations are based on internationally accepted principles, which include:

- the accreditation/status of the training institution which issued the certificate
- the minimum admission requirement for the course taken
- the minimum duration of the course
- the content of the course

- the examination requirements of the course.

Conclusion

The quality and scope of its education are central to the development and well-being of any country. Extensive and innovative technological development is essential if the numerous problems of praxis and provision in South Africa are to be solved.

The particular circumstances in the RSA obviously determine what would qualify as appropriate educational technology. The products and procedures must not only, in terms of their content and methods, suit the unique requirements of a varied population with divergent learning and teaching styles, needs and academic levels, but must also take the economic and practical constraints of limited financial and human resources into account. Carefully conceptualized and highly creative materials development is therefore urgently required for all facets of education in South Africa.

Locally developed products and expertise would obviously be preferable to most that could be obtained elsewhere, and could be expected to guarantee greater success at a considerably lower cost. The HSRC is committed to the task.

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3

TECHNOLOGY FOR MANAGING HUMAN RESOURCES

T.R. Taylor

It is almost a cliché to say that an organisation's most valuable resource is its workforce; cliché or not, this statement is undoubtedly true. As everyone knows we have a shortage of skilled manpower in this country. Managing human resources is therefore very demanding: the emphasis lies not only on effective utilisation but also (much more than in First World societies) on the *development* of these resources. And as we move into a new era in South Africa, the emphasis on development will no doubt grow stronger.

There are many facets to the management of human resources. These include: recruitment and selection; staff development and advancement; organisation development; industrial relations; and human resource planning. All human resource activities are aimed at one of or both the following goals: improving the effectiveness and productivity of the organisation, and improving employees' level of satisfaction with their jobs. These two goals might appear to be incompatible, but this is not necessarily so: individuals who are given the opportunity to develop their potential (and thus give their best to the organisation) are usually those who are the happiest.

The human resources manager should strive for the highest levels of equity in the workplace and eliminate all practices which might be discriminatory. This is not easy to do, but is an essential part of our move towards a more just society in South Africa; in any case, removing discrimination and optimising fairness serves both the goals mentioned above.

In the following sections of the chapter, we examine the technologies which are available to the H R practitioner in his main fields of activity to enable him to achieve the goals of organisational effectiveness and worker satisfaction.

Recruitment and selection

In order to fulfil current and projected human resource requirements in an organisation, staff has to be recruited. Some manpower needs can be satisfied by recruiting from within the

organisation and giving individuals the necessary training, but any company which maintains its size or expands has to draw on the external labour market. The type of applicants that an organisation attracts depends on its recruitment practices. For instance, if it advertises in a single newspaper, it is likely to limit its applicants to the segment of the population which reads this newspaper. This clearly has implications for employment equity.

Once candidates have applied for vacant posts, procedures have to be applied to select the most suitable applicants. If the organisation practises affirmative action, then further constraints are imposed on the selection procedure. A wide variety of methods of gathering information are used for the purposes of selection, including the curriculum vitae, biographical questionnaire, interview, and cognitive and personality tests. The information collected on a candidate is integrated in some way in order to make a selection decision.

Most large organisations, and many of the smaller ones, make use of psychometric tests as part of their selection procedure. In fact, apart from the interview, tests are the most widely used selection aid. There are several reasons for the popularity of tests, the most important being the following. Tests give information which is more objective than that obtained from most other selection techniques, and a person's performance can be quantified and compared with that of a reference group, such as other applicants for a particular job. Most tests are reasonably simple to administer and are not too time-consuming. Finally, and most importantly, tests have been shown to predict performance on the job or training course with fair accuracy.

The effectiveness of a test as a predictor of a work or educational criterion (i.e., its predictive *validity*) depends on a number of factors, including its accuracy and consistency of measurement (its *reliability*) and its relevance to the criterion in question. One cannot simply use any test for a given selection application. The test must be appropriate for the applicant population to which it will be applied and have satisfactory

psychometric properties in this population, and it must measure psychological characteristics which are important to successful performance on the job or training course for which it is being used as a selection instrument.

In order to meet the varied needs of test users, the HSRC markets a wide range of pencil-and-paper tests, each designed to measure a specific psychological characteristic, in a specific educational range. All these tests have been standardised and validated on South African samples and each is supplied with a manual which indicates suitable applications for the test and describes how to administer it.

In South Africa tests used in the human resources domain are classified into three categories or levels: A, B, and C. A-tests are mainly proficiency and ability tests which are straightforward to administer; B-tests are mainly aptitude and ability tests which are more demanding to administer; and C-tests are mainly personality tests and individual intelligence tests. The use of all psychometric tests must be supervised by a registered psychologist, and the interpretation of results done by him or her. However, the psychologist is not required to actually administer tests, and may delegate this task to suitably qualified individuals such as psychometrists and psychotechnicians. In the case of A-tests, the minimum qualification for an administrator is matric plus the successful completion of a short A-test user's course.

Tests have been classified into three categories and different administration requirements set in order to make testing as accessible as possible to organisations, without compromising standards of testing. As the majority of tests are A-level and thus are not highly demanding of a psychologist's time, most organisations can do testing in a cost-effective way. Costs can be further cut by hiring psychological expertise on a services-rendered basis rather than employing a psychologist full-time (however, larger organisations normally have one or more full-time psychologists on their payroll). Psychologists in

private practice as well as in the employ of the HSRC are available to perform a supervisory service.

Computerised tests

Psychometric tests have traditionally been administered in a paper-and-pencil medium; but in 1979 the then National Institute for Personnel Research (NIPR), in close cooperation with Eskom, began developing a computerised testing system that ran under the mainframe PLATO system. The test material was displayed on the computer screen and the subject responded by touching the screen itself (all PLATO monitors have this facility). Although the PLATO-based NIPR Testing System worked successfully for several years, the drawbacks of administration through a mainframe became apparent. Mainframe systems can be expensive to run and are prone to "crashing". By the second half of the 1980s, PCs had become ubiquitous and very affordable; thus the decision was made at the NIPR to develop a PC-based testing system.

Two computerised systems intended for a wide range of applications are now marketed by the HSRC, one produced by the Human Resources Group (the PsiTest system) and one by the Educational Group (SIEGMUND). In both systems the subject enters his responses by pressing specific keys on the keyboard. This task has been designed to be simple; experience with a keyboard does not give a testee an advantage. PsiTest is being sold to corporations for use on Local Area Networks and to individual psychologists with stand-alone PCs. SIEGMUND incorporates the more frequently used aptitude and intelligence tests. In both systems, the number of usages of programs is automatically monitored and the charge to the user is calculated on this basis.

In both systems access is controlled, and the chance of confidential information falling into the wrong hands is minimal. This is one of the advantages which computerised systems have over conventional testing methods. Computerised systems have

other advantages, including the following: automatic and error-free scoring, automatic conversion of raw scores to normed scores, reduced demand on testing personnel, greater flexibility in testing times, and the availability of additional scores, such as the length of time taken to answer each item.

The HSRC also markets another, specialised, system known as ART-90. This system is used to determine whether an individual is likely to be a high risk on the road. Although the ART-90 is not used, and is not likely ever to be used, as a screening instrument to decide whether a person is to be awarded a driving licence, it nevertheless has a number of applications. For instance it can be used to determine whether an individual is fit to drive after an accident in which he sustained brain damage; and it can be used to select professional drivers.

ART-90 comprises a microcomputer through which the testing is controlled and a console which incorporates a variety of stimulus and response apparatus, including a flicker-free monitor, banks of coloured lights, various press-buttons, and foot-pedals. The system includes several tests which have been shown to be related to road behaviour; each makes use of a different configuration on the console. The test administrator selects the tests he wishes to apply, and the executive program compiles this into a battery. A typical battery may consist of the following tests: sensory-motor co-ordination, choice reaction time, performance of multiple tasks under time stress, and intelligence. In addition, a paper-and-pencil personality test may be included in the battery.

There is a future for both conventional and computerised testing. Computerised testing has the advantages listed above, but conventional testing is the only viable option when large groups of people have to be tested simultaneously.

Simulations

Most tests measure underlying psychological characteristics, whether these be of a cognitive or non-cognitive nature. Before

assigning a test battery for a particular selection application, the psychologist should make an analysis of the tasks which comprise the criterion (whether this be a job or training programme). He should then assign those tests which measure the abilities that seem to be required in the execution of the criterion tasks.

For certain criterion activities, however, it is difficult to identify the critical abilities. In these activities, a whole welter of skills interact in a complex way, and merely measuring certain of these abilities does not lead to effective prediction of the person's likely performance. Running a small business is an example of such an activity. In cases such as this, simulating the criterion activity in the assessment situation can lead to much more accurate predictions of the criterion than applying a battery of tests.

A "game" which requires the player to run an imaginary small business has been devised by the HSRC: it is known as the "BIZ Game". A version of this game involving retail selling has proved particularly successful in distinguishing successful from unsuccessful business people. In a research exercise undertaken in conjunction with the Urban Foundation, the game was administered to two groups of business people; one group comprised individuals with a proven track record of success, and the other individuals who were only just surviving in the business world. The former group made much more money in the game than the latter (Boeyens, 1989). This version of the game is used by the Urban Foundation to shortlist loan applicants. A later version of the game is controlled by a microcomputer and can be used for both selection and training. This game involves both manufacturing and retailing. The player has to make a wide variety of decisions, such as what workshops and shops to buy, how much raw material to buy, how many manufacturing assistants and shop assistants to hire, whether to take loans and how much to borrow, how much to spend on advertising, how much to stock shops, and which lines to concentrate on. At the

end of the game, the computer prints out a whole range of information, from which an analysis of the player's performance can be made. This information can then be used to make a selection decision (with regard to granting a loan), or can be fed back to the player as part of a training programme. The player might then be asked to play the game a second time in order to determine the degree to which his skills have improved after the intervention.

Using information in a fair way to make selection decisions

The quality of decision-making in selection varies in terms of accuracy and fairness. Accuracy concerns the degree to which the following two errors are minimised: rejecting individuals who would have been successful on the job if they had been given the chance to do it, and accepting individuals who turn out to be unable to do the job even at the minimum acceptable level of competence. The selection psychologist should obviously strive to minimise both types of error, but under certain circumstances it might be more important to minimise one type of error at the expense of the other. (An example is selecting airline pilots, where it is essential to minimise the second type of error.)

Fairness is a concept which is usually, but not exclusively, applied to recognised groups (e.g., blacks and whites, women and men) rather than to individuals. In the selection context a given group might regard itself as unfairly treated if it feels (as articulated by some spokesperson or representative body) that its members are being prejudiced in the selection process and therefore are under-represented in the workforce of the organisation in question. The concept of fairness is complex, especially because there is no single, universally accepted, "fair" way of making selection decisions. One person's fair is another's foul. Just as people have not managed to agree on a single "best" ethical system, so they have not managed to agree on a best way of selecting candidates for jobs.

The lack of consensus in this domain does not absolve employers from adopting a particular fairness position or negotiating one with its employees. An organisation should espouse a particular system so that employees or prospective employees know the sort of organisation they are dealing with and so that selection procedures can be formalised and regularised. Various models of fairness exist, classifiable into three main categories: unqualified individualism, qualified individualism and quota. The nature of these models as well as their advantages and disadvantages have been presented in HSRC publications (Holburn, 1991; Taylor, 1990). Holburn and also Donald, Veldsman, Donald, Cook, Chemel and Taylor (1990) present step-by-step methodology for implementing fairness models.

An issue closely associated with fairness is that of test bias. Although tests are probably the most objective tools available to selection specialists, they are not perfect. The possibility always exists that a test is harder for a given group of individuals to do for reasons that are unrelated to the ability being measured. Many tests assume certain cultural knowledge. Suppose that a question (called an "item") in a test of numerical ability is couched in the context of a rugby game and assumes a basic knowledge of the game (for instance, the number of points scored in a try). An item of this type would be likely to be more difficult for certain groups to do simply because rugby is not really part of their culture. Such a question would be biased.

Questions as obviously biased as this seldom appear in published tests; but more subtle cultural factors sometimes do cause bias. For the past few years, tests published by the HSRC have been subjected to bias research, and relatively few items have been identified as biased on the sophisticated tests of item bias which have been applied; an exception is in the personality domain, where bias may be more prevalent (Owen, 1989; Taylor & Boeyens 1991). Non-verbal tests (for instance reasoning tests

which make use of diagrammatic stimulus material) generally show little evidence of item bias.

There is a second form of bias known as predictive bias, which concerns the relationship between test scores and performance on the criterion (which may be an aspect of work or a training course). This relationship between the predictor (the test) and the criterion can be described by a graphical line known as a regression line. There are three critical parameters of this line: its slope, intercept with the vertical axis, and the error of measurement. Predictive bias might be somewhat more prevalent than item bias. In the USA predictive bias has generally been found to favour less privileged groups; there is no guarantee, however, that the same will be found in South Africa. Test-using organisations are advised to check whether there is any evidence of predictive bias in their particular applications. Many organisations do not have the technical skills to do the analyses required; however the HSRC is able to do the required analyses on a consulting basis. Also, the HSRC has made available a computer program known as NTS which runs on a PC; this is a user-friendly package which performs all the common psychometric analyses, including bias analysis.

Development and advancement

Selection is of course only the first step in managing personnel. Once appointed, an individual has to be developed to be useful to the organisation. The purpose of this process is twofold: to utilise the person's potential optimally, and to make the individual's career as rewarding as possible. Thereby the needs of both the company and the individual are served. The organisation benefits by taking the needs of the individual into account as much as possible (but obviously this has to be done within the constraints of organisational functioning), because a satisfied worker is more likely to give of his best and to be loyal to the organisation.

There are several personnel management procedures concerned with staff development. We shall deal with a few of the main ones below.

Training

When an individual comes into an organisation, he brings with him certain basic knowledges, skills, abilities and other attributes (KSAOs) which are of value to the company. However, the organisation has specific needs in this regard, and no individual coming into a company is ever perfect for the organisation's requirements. Therefore the organisation has to put certain knowledges, skills, etc. into the individual. This must be done, of course, within the constraints of the individual's potential, and take into account, to as great an extent as possible, his own aspirations.

Larger organisations employ training personnel who design many of their training programmes. However, the in-house trainers might not be in a position to create certain more specialist material, especially that which is designed on psychological principles. Three packages of this type which are marketed by the HSRC are briefly described in the following sections.

The 6M package

This package is intended to teach basic business principles to individuals with low levels of education, and who may have come from a background where they had little contact with business concepts. The six "Ms" are: Men, Money, Materials, Market, Machines, and Management — the most important elements of business activity. The package has been progressively developed over more than a decade (it started life as the 3M simulation) and has established an impressive track record. Over 500 companies have implemented it with very positive results in most cases — assessed in terms of changed attitudes, increased productivity, and reduction in industrial action and in wastage. Research has shown that many workers at lower levels in the hierarchy are remarkably ignorant about a

number of aspects of business. For instance, some think that raw materials are free — so why worry if much of it is wasted! Others believe that the managing director takes all the profits for himself. Many do not understand, or are distrustful of, the concept of profit. The 6M is designed to correct misconceptions and give trainees an overall view of the functioning of a business — the interaction of the six Ms. Then they have a better idea of where they fit in the process and how their work contributes to the success of the company; they also realize the importance of competitiveness and efficiency in a free enterprise economy and how this relates to their own job security and material wellbeing. The motivational implications of such a training exercise are self-evident.

A version of the program is custom-built for each organization that decides to implement it. Both text and materials are developed to represent accurately the organization in question; this aids comprehension on the part of trainees and helps them to "project" themselves into the exercise. The program makes use of scale models to illustrate the business environment, and in particular the six Ms. There is also a model to represent the opposition. The dynamics of business activity are created by moving materials from one location to another. The program is administered by an instructor who is thoroughly trained to present it in a professional fashion and to promote comprehension. At the end of the program, understanding is assessed with a short test.

Some of the improvements that have been achieved as a result of the implementation of the 6M are very impressive. For instance, a chemical company in Natal experienced a 25% reduction in the incidence of output that had to be reworked; and accident rate among payroll employees dropped by over 30%. In a construction company in the Transvaal, absenteeism reduced from 13% to 2,6%; attendance on Monday following payday increased from 26% to 89%; and worker's compensation claims for accidents reduced from R28 000 in 1988 to R500 in 1989. There

are many more cases of dramatic improvements as a result of the implementation of the 6M.

Supervisor and management courses

An area where there is a great need for training is in supervision. This need extends from the lowest level to the highest. The HSRC offers several courses to improve the quality of supervision and management. At the lowest level, there is a course for illiterate or semi-literate team leaders. This course covers a wide range of topics, including the following:

- objectives and structure of the organization in question
- functioning and composition of the trainee's department
- planning and organizing work
- control (cost, production, etc.)
- problem solving and decision making
- communication
- motivation and human relations
- selection, placement, and labour utilization
- inducting staff
- instructing staff
- discipline and handling grievances
- safety and health of employees.

A companion — and somewhat more sophisticated — course in supervision has been created for literate first line supervisors. In addition to the topics listed above, this course also includes a module on industrial relations.

Mentoring package

At levels higher than first line supervision, mentoring becomes an effective means of preparing people for advancement. A mentor is a manager or experienced person, regarded by the organization as an expert and top-rate performer, who becomes involved in an interpersonal relationship with a more junior or less experienced person, the purpose of this relationship being to develop the less experienced person, or "advancee". The

relationship between the two is the business equivalent of the relationship between a professor and a postgraduate research assistant.

The third "player" in the mentoring situation is the advancee's supervisor, who is often not the same person as the mentor. The HSRC has created course material to guide the mentoring process; one set of material is written to be relevant to the advancee and a second set is designed to guide the mentor and also the supervisor. Apart from clarifying the roles of mentor and advancee and other relevant concepts, the programme includes a number of exercises (many of them done in groups) which are intended to help the players to be more effective in their roles and hence to facilitate the mentoring process. The following is an example, drawn from the mentor/supervisor course material, which is intended to improve counselling skills. The mentors are brought together as a group and then divided into pairs. Each participant is then asked to think of a typical situation in which his advancee might seek help from him. One member of each pair then role-plays the situation with his partner (who takes the part of the advancee). Thereafter the partners swop roles and do another role-play. Finally, each role-play is enacted in front of the whole group who give feedback on a number of dimensions, including genuineness, understanding, clarity, simplicity and concreteness. Advancees do similar exercises appropriate to their situation.

The course is done in the organization and extends over a period of about eight months. During this period there are several two-to-four day training sessions for mentors and advancees.

Self-development

The HSRC also offers self-development courses for managers. There are two of these. The first has as its target group line managers or middle managers who are interested in advancing their careers. This course, which extends over three days, can be

divided into three parts. The first part covers management development in South Africa. It looks at the current position of management development in the country and pays special attention to the changing role of the manager, new challenges managers have to face and factors influencing management development. The second part concentrates on management skills. It places emphasis on interpersonal and conceptual managerial skills such as problem-solving, decision-making, planning, organizing and controlling, as well as effective communication and assertiveness. The final part covers self-evaluation and career development. Each trainee gathers a wide variety of information about his skills. The techniques used include feedback from questionnaires, practical exercises, interaction with the rest of the group, and interaction with the instructor. This self-evaluation is followed by a SWOT analysis (analysis of strengths, weaknesses, opportunities and threats) which serves as the basis for setting career goals. These goals are set for a term of three to five months, after which progress is evaluated.

The other self-development course is intended for the immediate supervisors and other seniors of managers who have completed the course described above. The rationale of this course is that the successful implementation of knowledge and skills acquired during a training exercise is dependent on the support of colleagues, and especially seniors. The goal of the course is therefore to inform seniors of the input given to subordinates during the course in self-development and career planning as well as to investigate their role in the career development of their subordinates. Like the other course, this one has three parts; these parts, however, are covered in only two days. The first part is aimed at developing an awareness in the senior of his supportive role for his subordinates and of the factors in the organization that promote or hinder the development of human resources. In the second part, attention is paid to the mentoring relationship, the stages of the mentoring

process, and critical mentoring skills. In the final part of the course the seniors receive an overview of the input which their subordinates received, along with a complete manual. Thereafter, seniors meet their subordinates in a workshop situation where the subordinates' development needs are collectively examined (on the basis of the SWOT analysis mentioned above). This is used to establish career goals for the subordinates.

Career development

Almost all employees need to feel that their careers are going somewhere. Few people are willing to do the same job year after year without any prospect of advancement or of learning new skills and facing new challenges. Doing a job is a developmental experience: as time passes the incumbent acquires competencies, and the feedback which he receives from supervisors and others, as well as his personal evaluation of his performance, has an impact on his goals, aspirations and self-image. At some point he is likely to feel the need for a career move in order to accommodate his evolving conception of himself and his career.

Career development ultimately depends on the organisation: it has the power to promote or shift personnel, and to re-design (or enrich) jobs. But the individual obviously also plays a role in developing his own career, for instance in showing willingness to take on new challenges and utilizing every opportunity to acquire skills, knowledge and experience which are useful for careers at higher levels in the hierarchy. Career development is a complex process because it involves taking into account a number of factors, some organisation-centred, some employee-centred. Some of the former are: organisational efficiency, constraints imposed by job hierarchies, rules and requirements for promotion, manpower needs, and training opportunities; and some of the latter are: personal aspirations, abilities, and developmental potential. There may be organisational requirements which impose unnecessary

constraints on career development. An example is a staffing rule which stipulates (for no good reason) that an individual must be in job **x** for at least 5 years before he may be considered for promotion to job **y**.

Career development cannot be done effectively in the absence of information. This information falls into various categories: information about staffing policies, about job structures, about person specifications for given jobs, about job opportunities, and about the job incumbent himself. The information should be available to individuals who make decisions on the job incumbent's career (supervisors, the personnel officer, career development specialists, etc.) *and* also to the job incumbent. An individual feels more in control of his career if he has access to career-relevant information. The information about the incumbent is largely of a psychological nature and therefore should be obtained by a psychologist skilled in career development. The techniques necessary to obtain this information are sophisticated, and many organisations require the assistance of specialist career development consultants. The HSRC has in fact developed an entire procedure of career development and offers this as a service to organisations (Christierson, 1979).

Before seeing the job incumbent, the career development specialist obtains all relevant information from the client organisation, including a detailed job description and organogram. A test battery is assigned, usually consisting of both cognitive and non-cognitive assessment instruments. The specialist then goes through all the information collected on the individual in order to plan the basic material to be covered in an interview with the incumbent. This interview, which usually lasts at least an hour, is the most skilled part of the procedure. Once this is over, the specialist is then in a position to offer expert advice to the client organisation on how best to utilise the person to the benefit of both individual and organisation.

Feedback to the company is given in the form of a detailed report of several pages. This report covers a brief background of the job incumbent's work history, an evaluation of his cognitive skills and potential, emotional maturity and personality characteristics; all this information is integrated and related to the opportunities available in the organisation, taking into account specific organisational constraints or requirements. On this basis, a set of recommendations is made on the most promising options for developing the individual's career.

Performance management

A person's advancement in an organisation depends largely on his performance, or rather on his manager's evaluation of his performance. Performance is not a function only of factors within the employee: depending on the way in which he is managed, he will be more or less productive. Productivity can be optimised through a system of co-management, in which the individual and his supervisor mutually agree on a set of goals to be achieved in a given period of time. The responsibility for achieving these goals is also joint: the organisation provides facilities, opportunities, support and encouragement; and the individual puts in the effort and applies his skills and knowledge.

Evaluation or appraisal of performance is a critical part of performance management. Yet the procedure is often not taken seriously and may even be viewed with cynicism. Many organisations simply go through the motions of doing performance appraisals every six or twelve months; managers and their subordinates may be engaged in a kind of unarticulated conspiracy to get it over with, with minimum fuss and repercussions for all concerned. There are two sets of reasons why performance appraisal may become the Cinderella of personnel management procedures in an organisation:

1. The appraisal method is not sufficiently objective, is not job-relevant, or has other serious measurement shortcomings.

2. It is not linked to career development, rewards (whether these are positive or negative), or goal setting: in other words it is not integrated with other aspects of career management.

These shortcomings may lead to accusations of unfairness, and in addition can have implications for work motivation.

In order to assure job relevance and objectivity, performance appraisals should be based on the actual content of the job, the tasks and responsibilities which the incumbent has to perform. Performance on each of these is evaluated against clearly specified benchmarks; the evaluations are then integrated into an overall score, preferably taking the importance of each task into account. The performance appraisal, therefore, should not be done in the absence of a job analysis and job description.

A performance appraisal is normally thought of as a retrospective activity: it looks at the performance of the individual over an assessment period which has just come to an end. But this is also an appropriate time to set goals for the future. These goals should be set with the aims of overcoming weaknesses in the individual's performance (as identified in the appraisal), and of preparing the individual for future job roles. Both incumbent and supervisor should be involved in the goal-setting process. The degree to which the incumbent achieves the goals (taking into account organisational constraints) should be evaluated as part of the next performance appraisal. Also, the appraisals should have a real impact on the individual's compensation and career opportunities. Performance appraisal is then integrated into an overall process which justifiably can be called performance management.

One of the great advantages of effective performance management is that it is highly motivating. The reasons for this are the following:

1. The job incumbent is better informed as to what is required of him to do his job effectively and to prepare himself for jobs higher up the hierarchy.

2. He participates in setting his own goals and thus is more committed to them.

3. He can see the that the appraisals have a definite impact on his career: goals become a part of future appraisals and appraisals have a marked effect on career advancement.

Performance management is therefore a complex process which requires sophisticated tools; these are available from the HSRC.

Organisation Development

Organisation development (OD) as a distinct concept has a fairly short history; the term entered the lexicon of organisational specialists only in the 1960s. It is defined as follows by French and Bell (1973, p. 15):

> Organisation development is a long-range effort to improve an organisation's problem-solving and renewal processes, particularly through a more effective and collaborative management of organisational culture — with special emphasis on the culture of formal work teams — with the assistance of a change agent, or catalyst, and the use of the theory and technology of applied behavioural science, including action research.

"Problem-solving processes" means the way the organisation goes about diagnosing and making decisions about the opportunities and challenges of its environment. As a rule OD is not successful if attempted entirely from within; an external expert — the "change agent" — who has no axe to grind and no empire to defend, and who is in a better position to see the big picture, is required to guide and motivate the process. However, this expert never takes over: the organisation itself

must assume responsibility for the changes which are introduced.

Action research is a crucial component of the renewal process. The basic steps of action research are the following:

1. Preliminary diagnosis
2. Data gathering from the client group
3. Data feedback to the client group
4. Data exploration by the client group
5. Action planning based on the findings and intended to serve the purposes of OD
6. Action.

The acquisition and interpretation of organisational information is therefore central to OD, for otherwise the process of change is blind and is bound to fail in its purposes.

Survey methods

The HSRC has survey methods that can be used to pinpoint dysfunctional processes in an organization and scan the human relations climate at all levels of the organization. These surveys can give an early warning of issues requiring attention from management before morale problems develop. And they can be used as a baseline from which to evaluate the effects of OD. Particular applications where the surveys are useful are: as a foundation for strategic planning; labour-management negotiations, and staff development.

The surveys sample staff and management attitudes and perceptions in some or all of the following areas:

- Recruitment
- Selection
- Induction
- Training
- Performance appraisal
- Career development

- Management and supervision
- Communication
- Discrimination or favouritism
- Grievance handling
- Industrial relations
- Remuneration and benefits
- Health and safety
- Overall job satisfaction
- Organizational climate.

The surveys can take the following forms:

- In-depth interview surveys providing both qualitative and quantitative information
- Self-completion questionnaires
- Focused in-depth or questionnaire surveys intended to be directed only at certain segments of staff or at certain functions within the organisation.

The decisions as to what form a survey should take, which issues should be included, and which topics should receive special focus, are made by the survey organisation after extensive consultation with the client company. The findings of the survey can form the basis of the action research and transformational process. Further surveys may be taken at a later stage, for OD is not a once-off intervention.

Organisational structure

Organisational change often necessitates organisational restructuring. The restructuring may involve large units such as divisions, but often also smaller structures such as job ladders, job families, individual jobs, or even tasks which form a part of a job.

Even in stable circumstances it is necessary that structures be adequately specified. In particular it is important that the content of each job in the organisation be analysed and described. This information is required for a number of purposes. The job incumbent must have a document which describes his

responsibilities; selection and placement cannot be done without information on the content of the job; performance management also cannot be done effectively without it.

In circumstances where organisational structures are being changed, the need for detailed job information is even greater. Jobs and job hierarchies cannot be modified to optimise work efficiency and worker satisfaction unless a detailed analysis of work is made. The HSRC has a number of techniques designed for this purpose, ranging from task analysis, through job analysis, to methods for describing jobs and job families.

A special form of job analysis is required for the determination of salary structures: job evaluation. The HSRC's job evaluation package is known as the "Q" method. It is certainly not the only one on the market; there are other well-known techniques such as the Peromnes and Hay systems. In the Q method, jobs are ordered on a continuum by taking three factors into account: decision making complexity, the controls under which the individual works, and contact with people. Information on these three factors is integrated to order jobs on an interval scale; this ordering in turn is used to determine salaries. The developers of the Q method were aware that the usefulness of a job evaluation system is very much dependent on the quality of information that is used as an input; therefore they gave attention to the development of more objective and reliable procedures for obtaining information (Van Rooyen & Verwey, 1981).

Managing change

The change which occurs in organisational development is destabilising and can lead to chaos if not managed effectively; it can also be very stressful for all involved. Managing change is especially demanding at present because the environment outside the organisation — political, social, economic — is also in a state of flux. It is essential that managers acquire skills for managing change; otherwise change will manage *them*.

Managers participating in an OD exercise know that change is fundamental to the process, but nevertheless might not be equipped to handle it emotionally, conceptually, or both. Change can affect organisational values, climate and culture, and this can be threatening. From a cognitive point of view, change demands of managers that they think more diagnostically and anticipatively.

Expert intervention might be required to assist managers to cope with change. The HSRC has a program which involves managers at all levels in the organisation. It aims at creating an awareness in the manager of the importance of cultivating a number of perspectives or orientations and moving flexibly between them as the situation demands. Managers are encouraged to spend more time planning and attending to motivational problems which might arise in staff as a result of the change process.

Industrial Relations

The issue of industrial relations had a rather low profile in South Africa until the mid-seventies. The balance of power was very much on the side of management, and labour was largely powerless. But with the legalization of black trade unions and the slow but sure disintegration of the main pillars of apartheid, this situation began to change. Today the balance of power has shifted to the extent where negotiation has replaced a "baasskap" approach on the part of management, and all large organizations realize the need for management to pay attention to industrial relations and to put mechanisms in place to accommodate a whole range of management-labour problems that can arise. Without such mechanisms, industrial strife is likely to result.

The HSRC has several products that can assist organizations to improve industrial relations or reduce the probability that relations will degenerate to the point where strike or other industrial action will occur. We shall discuss these briefly below.

Survey and other investigative methods

We have already mentioned these methods as an essential component of organisation development; they also have an important application in industrial relations. Surveys can be designed to investigate issues specifically relevant to work relations. These surveys can involve open- or closed-ended questionnaires or face-to-face interviews using a structured or semi-structured format.

Surveys of this kind are diagnostic: they make it possible to pinpoint sources of unhappiness, frustration, or anger. Once this has been done, it is then possible to implement steps to remedy the specific problems that have been identified.

Other investigative methods can also be applied: for instance an analysis of the organizational structure to determine whether adequate upward and downward channels of communications exist to handle grievances and disseminate information; and an evaluation of remuneration packages to determine whether these are market-related for all categories of work. Once problems have been pinpointed, these can be addressed.

Negotiation techniques

Skills in negotiation are critical to the peaceful and successful resolution of disputes. Unfortunately, too few people who are called upon to negotiate actually have effective negotiation skills.

The HSRC has done an in-depth study of negotiation and has developed a taxonomy of the critical elements of negotiation. A negotiation process can be split up into these elements, and can be effectively summarized using them. The style of skilled negotiators, as reflected in such a summary, differs markedly from the styles of unskilled individuals; and the summary makes it possible to identify where these differences lie.

This methodology forms the basis of an HSRC training program in negotiation skills (Nieuwmeijer 1988). One is not simply "born" with such skills: they can be taught. With training,

an indifferent negotiator can be turned into a much more effective one.

Training in aspects of industrial relations for first-line supervisors

One normally thinks of industrial relations as undertaken by representatives of the labour force and senior members of management. This is largely true, but it should not be forgotten that top management are not the first to encounter or become aware of problems in the workplace. The first person in the chain of command who encounters these problems (and who might be in a position to resolve them before they become too serious) is the first-line supervisor. Inept handling of such problems by a first-line supervisor can exacerbate them. It is therefore important that first-line supervisors have some knowledge of sound industrial relations practice, and to this end the HSRC has incorporated modules in its first-line training manual that deal with industrial relations and grievance handling issues.

These modules do not try to turn the first-line supervisor into an industrial relations negotiator, but present a perspective that is relevant to his position and discuss his role in resolving industrial relations problems. Topics covered include:

- What is a grievance?
- What steps should the first-line supervisor take when confronted with a grievance?
- What is a grievance procedure?
- What is meant by industrial relations?
- The first-line supervisor's role in industrial relations
- Structures of industrial relations
- The trade union in the company
- The first-line supervisor's role in dealing with trade union representatives
- What the first-line supervisor should do in a strike.

Industrial Relations Film

An effective grievance procedure can be a sort of lightning conductor in reverse (in other words, upward directed), and can prevent the whole organizational structure from catching alight or being destroyed. Unfortunately both management and workers do not always realize this. Industrial action can arise because there are no structures and processes to handle grievances or because these are not used properly.

For this reason, the HSRC commissioned the well-known director Kevin Harris to make a film on the effects of poorly handled grievances. The film — *Indaba ye Grievance* — is the story of a migrant worker in the building industry. One of a group sharing a room in a hostel has lost his job through conflict with his supervisor. The main character, Sam, then tells of his experiences with good and bad supervisors (illustrated by scenes at work) and how the tension between him and a bad supervisor builds up to a fight and a strike. Getting nowhere with the strike, the workers negotiate with management for their reinstatement and the setting up of a grievance procedure. There is another crisis with the supervisor but this time the grievance procedure is used.

What sets this film apart is that the action is seen from the workers' point of view. Kevin Harris used employees and managers instead of professional actors, resulting in a story which employees have described as highly realistic. As much of the dialogue is in Sesotho, a narrator explains what is taking place. Two versions of *Indaba ye Grievance* are available, one with narration in English and the other in Zulu. It is available in 16 mm film and video formats.

Although the film is mainly intended to be shown to workers, managers often benefit from seeing it, as it gives them a different perspective on the management-workforce interface. The film is intended to be supplemented by group discussions in order to get the most benefit from it. A guide in the form of a slim booklet is provided by the HSRC to help facilitators to run group

discussions. The film is first run right through and then is restarted and stopped at a number of points. The audience is split into smaller groups and at each pause these discuss some aspect of the film. Questions put by the facilitator focus the groups on issues relevant to industrial relations, especially the grievance procedure.

Although the film is by no means a propaganda tool for either workers or managers, it is intended to make viewers think about the negative implications of not trying to resolve problems or conflicts through negotiation; it is also intended to highlight the crucial role that effective grievance-handling mechanisms play in the resolution of dissatisfactions that inevitably arise in the workplace.

The effect of the film on viewers was evaluated by Godsell, Hall and Tomaselli (1985).

Human Resource Planning

Human resource planning is concerned with strategies to obtain sufficient manpower in the future. To do this, projections are required as to manpower supply and demand in various employment categories; these in turn are dependent on a wide variety of factors — ultimately all socio-political events in the world. Of course it is quite impossible to take everything into account; the art of making accurate projections is to create a model of the future which takes the most important factors into account and assigns realistic values and weights to these.

Manpower projections and planning can be done on a number of levels, from national to individual organisations. At the national level, planning involves taking a macro look at the future manpower needs of the country with regard to the type and level of skills required and geographical areas where jobs demanding given skills will be cited. This information can then be used to plan the type, location and quantity of various educational institutions.

The HSRC is involved in developing such macro perspectives, as well as translating these into scenarios and plans of action for given sectors of the economy, industries, or individual organizations. A three-phase conceptual model is employed. The phases are: situation analysis, the development of alternative strategies, and the formulation of a strategy for developing human resources.

During phase 1 a detailed analysis is done of the main components of human resource planning, namely demand and supply, taking demographic, technological, job level, economic, political, social, and skill factors into account. This analysis enables an estimate to be made of future demand, and an evaluation of the capacity of training institutions and facilities to satisfy the projected demand.

The model of supply and demand as conceptualized in phase 1 forms the basis of phase 2, the development of alternative scenarios and strategies to address various scenarios. These are derived by making different assumptions for critical factors, including those listed above. Some of the scenarios might indicate a serious imbalance between the supply and demand of human resources; such scenarios obviously have implications for decision makers at national and organizational levels.

In the third phase, the most plausible scenario is identified and a strategy worked out in detail to address it. The most important part of this strategy is the setting in motion of steps to develop the manpower that appears to be required in the future. Part of this process could be the identification of shortcomings in existing formal and non-formal educational systems, and the formulation of proposals to redress these shortcomings. After the macro analysis has been completed, the implications can be determined for structures at lower levels, including the micro (organisational) level. An organisation can take these into account when performing its own human resource planning exercise.

Conclusion

In this chapter we have covered the most important aspects of human resource management: recruitment and selection, development and advancement of employees, the "people" aspect of organisational development, industrial relations, and human resource planning. All these domains are complex and require specialised knowledge if they are to be managed effectively and fairly. This expertise is not always present in the organisation, especially medium and smaller organisations who cannot afford to retain highly specialised personnel on a full-time basis.

Managing these domains also requires sophisticated "tools", which as a rule are not developed in-house, either due to the time-consuming nature of the development, or to lack of expertise in the organisation.

The HSRC has a wide range of know-how on human resource management and also a number of very useful technologies ranging from psychological tests to techniques for conducting negotiations with unions. It can therefore offer a comprehensive and balanced approach to solving most human resource problems.

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HUMAN SCIENCES TECHNOLOGY IN MANAGING PROBLEMS ARISING FROM SOCIAL ISSUES

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Introduction

What the Human Sciences Research Council shares with all development agencies is its commitment to the establishment and maintenance of the optimally functioning society. This well-being is to a large extent related to

(a) social health, that is a society's willingness and ability to care for the less fortunate, such as children with problems, the poor and the aged, the victims of crime and drug abuse and social outcasts;

(b) political and constitutional stability, which is a precondition for economic growth and social development;

(c)socio-economic development, that is the planning, creation and maintenance of the physical, socio-economic and cultural infrastructures needed to enhance the quality of life; and

(d) social interaction and communication, which in a highly stratified society, are conducive to the assessment of needs, the reaching of agreements, effective consultation and co-operation, and the management of conflict.

Social welfare and security

In the pursuance of the HSRC's social welfare objectives, *inter alia* the promotion of social well-being and community safety, programmes and prevention techniques have been developed and empirically tested to address some of the social issues that need urgent attention. Social issues that have received particular attention are alcohol-related problems and crime.

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It is widely accepted that the provision of accessible and affordable services for addressing alcohol-related problems is not only a necessary, humane, life-improving and life-saving opportunity for those experiencing such problems, but could have a long-term impact on containing the cost of health care. In order to plan rational preventive and treatment programmes that are likely to yield the desired outcome, service deliverers need information on the nature and the extent of the alcohol intake of the people they serve, and on the nature and magnitude of the alcohol-related problems that are manifested among them. Researchers in the HSRC have therefore developed and in some instances adapted techniques and devices for scientifically collecting some of the alcohol-related information needed for effective service delivery in preventing and treating alcohol-related problems:

- The Khavari Alcohol Test (KAT), for example, is a quantity-cum-frequency technique to determine alcohol intake. The test, adapted by an HSRC researcher to suit South African circumstances, is more precise than most of the other indices used for this purpose. Consequently the KAT facilitates a detailed, statistical and empirical differentiation of various types of drinkers in terms of the quantity and the frequency of their intake of various alcoholic beverages instead of the traditional classification of drinkers into fairly arbitrarily predefined nominal classes, such as light, moderate and heavy drinkers. In this way the KAT overcomes the limited generalizability and therefore the restricted scientific usefulness of traditional quantity-cum-frequency measures of alcohol intake. Apart from enabling a beverage-by-beverage analysis of the frequency, quantity and quantity-cum-frequency of alcohol intake, the KAT measures the variation in a person's intake pattern over a particular period. The KAT has another advantage - it includes items on alcohol intake that parallel those used in most other quantity and frequency indices of alcohol use. The KAT is as useful in community studies as in

clinical face-to-face assessments of the nature and extent of alcohol intake. Indeed, since the beginning of the 1980's the KAT has been successfully used among a variety of demographic categories in the HSRC's periodic national updates on drinking practices in the RSA. These updates provide preventive agents in the field of alcohol-related problems with essential baseline information.

- To assist in scientifically estimating the magnitude of alcohol-related problems in a community, the Jellinek-Walsh-Ledermann-Khavari formula (technique) was devised by an HSRC researcher. This technique is based on the argument that a multifaceted measuring instrument overcomes to some extent the inherently biased nature of data collection methods. Indeed, this model assumes that some validity may be claimed for data collected in various independent ways and showing similar trends. A set of multisource data (estimates of the incidence of alcohol-related mortalities, admissions to alcohol-related rehabilitation/treatment centres, taxed sales of alcoholic beverages and self-reported level of alcohol intake in a community) is analyzed by means of the technique. The particular trends are subsequently identified. This formula assists policy makers in monitoring the adequacy of treatment facilities in the RSA and in prioritizing the needs in this respect.
- Another device, that has been developed by an HSRC researcher, can be used to prevent the misuse of alcohol and drugs. The technique is called the Rocha-Silva model and is rooted in general sociological theory and based on South African sociological research on deviant drinking. It provides a general psychosocial framework for understanding the onset/continuation of alcohol/drug taking and consequently of alcohol/drug-related problems. It coincides with the World Health Organization's public health model of the prevention of alcohol/drug-related problems, and specifically the latter model's assumption that the extent of the demand for and accessibility to alcohol/drugs in a

community will correspond with the extent of alcohol/drug-related problems. In fact, the Rocha-Silva technique provides a national and international basis for decision making in prevention research. The technique provides a basis for making rational decisions concerning what to research, how to interpret research data and what should be given attention in prevention programmes. This technique has been used effectively by the HSRC to assist national preventive agents in the public and private sector in the RSA to act pro-actively and cost-effectively by rationally identifying and addressing priorities in the field of alcohol/drug-related problems.

The continuous rise in crime and delinquency rates necessitated the development of accountable and effective techniques for the measuring, monitoring and implementation of scientifically sound data aimed at developing assistance programmes and prevention strategies in the field of social security. The following models were designed:

- VICTIMLINE is a time-limited intervention model that was developed by researchers of the HSRC, other experts in this field and trained volunteers, to provide the emotional support, information and referral needed to prevent long-term psychosocial problems experienced by crime victims who did not have the benefit of timely victimological support. This model thus makes provision for a better deal for the victims of crime within the framework of systematic evaluation and developmental research. In South Africa, apart from fragmented programmes for battered women and for the victims of child abuse and rape, little attention has been given to the needs of victims of other crimes. The sharp increase in the crime rate and the escalation of violent crimes in the 1980s necessitated an expansion of services for all victims of crime in this country. The development research and utilization model is used as a basis to set specific standards for the scientific analysis, development, evaluation and distribution of services according to the needs of the consumers of the service. Process evaluation (ongoing

evaluation and modification are undertaken until the victim support model has proved to be practical and the desired aims have been reached) and outcome evaluation (whereby the overall effectiveness of this model is measured) are integral parts of VICTIMLINE.

- CRIMEPAT was developed by HSRC researchers to analyze the patterns of crimes in South Africa with the aim of developing targeted crime prevention programmes in the community. This technique facilitates the scientific construction of a profile of the offender (age, cultural background, previous offenses, occupation, etc.), of the victim (age, cultural group, gender, socio-economic level, etc.) and of the circumstances in which the specific crime occurred (the framework of time and place, behaviour of the offender before and during the crime, the means used by the offender to commit the crime, the reaction of the victim, the crime itself, the behaviour of the offender and of the victim after the crime, the cost of the crime to the victim, etc.). Such profiles are crucial to understanding the pattern of specific crimes (murder, rape, serious assault, common assault, etc.). This understanding facilitates the identification of high-risk situations in which crime can easily take place and for the development of targeted situational crime prevention programmes.

  CRIMEPAT therefore has important implications for the study of victimization and for the development of programmes aimed at preventing specific crimes (e.g. the sexual abuse of children). This technique puts its users in line with one of the most promising future trends in crime prevention strategies, namely the utilization of crime data to analyze local crime patterns in order to develop targeted community crime prevention programmes.

- PEERS has been developed by HSRC researchers as an experimental strategy for the resocialization of marginalized youth. Because of the long-standing and ongoing breakdown of family life, school and community life in township areas the majority of the South African youth will not be able to develop into productive adults unless they receive

immediate help. The vision of a democratic, just South Africa is clouded by a looming crisis involving millions (more than 12 million) of marginalized young people. Because they became socialized in an environment of criminal and political violence, these youngsters grew up unsupervised and without respect for the values and norms of conventional society. PEERS is based on the findings of HSRC researchers that the marginalization or disconnectedness of young people from society often leads to juvenile delinquency and crime. These youngsters are often excluded from a network of support that is vital to the development of social skills and moral values. Young people need to feel secure in their relationships and have to have a "sense of belonging" in the world before they can accept responsibility for their own lives and those of future generations.

PEERS is a comprehensive and cost-effective strategy developed to help young people to rehabilitate marginalized peers themselves. This programme consists of the following elements:

- the provision of special opportunities for meaningful development;
- the development and/or replacement of informal psychological support networks and;
- the provision of interpersonal skills training to enable youngsters to fulfil their responsibilities and to utilize the support systems available to them. PEERS aims at training young people as lay counsellors in their own communities. This programme is based on the assumptions that young people have positive strengths which if nurtured can produce beneficial results for themselves and their communities and that peer groups have the strongest influence on the values, attitudes and behaviour of other youngsters.

PEERS is aimed at empowering the youth to become involved in a comprehensive strategy for the construction of a new value system necessary to the development of a democratic society by:

- creating an understanding of oneself and of others, e.g. of one's own survival, protection and development needs and rights, and teaching respect for the rights of other individuals and groups;
- understanding the value that groups hold for personal growth;
- teaching self-awareness and transactional analysis;
- learning about the dynamics of helping and about helping skills;
- perceiving human needs and gaining self-understanding;
- responding to the feelings of others and cultivating tolerance for and the accommodation of other cultures;
- learning about the community and identifying community resources;
- developing and strengthening informal psychosocial support networks and the peers' sense of belonging;
- learning and teaching interpersonal skills, e.g. communication, decision-making, active listening, honesty about one's own feelings and handling confrontation and interpersonal conflict.

- CRIMESTOP was designed by HSRC researchers as a blueprint for the primary prevention of crime on a micro (potential victim or household), meso (community) and macro (policy) level. Because crime and the fear of crime could potentially disrupt the whole process of creating an equal and just society, a national crime prevention policy for South Africa should be a priority. Local crime prevention strategies have until now been aimed largely at the (pre)offender and not at the (potential) victim. The recent upsurge in the crime rate suggests that these responses, based largely on the actions of the official criminal justice system, have failed to address the crime problem effectively. South Africans are beginning to realize, as most citizens in overseas countries do, that a victim-oriented approach may be more useful in the prevention of crime. Crime control can no longer be regarded as the sole responsibility of the police, the conventional court

and penal system, but should be the responsibility of every potential victim and of society as a whole. Crime should therefore be addressed as a community problem and crime prevention be regarded as part of the fibre of community life. Such a strategy should include the following elements:

- a national council for crime prevention aimed at developing co-operation between ministries, local government, police, voluntary organizations and the private sector
- a national crime monitoring system developed through the systematic collection, analysis and interpretation of formal and informal crime data
- the development of local crime prevention programmes by researchers in collaboration with concerned community members
- media campaigns geared at informing and training the public in its civic responsibilities
- the systematic evaluation (of process and outcome) of programmes and strategies to prevent crime.

The use of self-help principles should make it possible to develop a perspective that may place the blame for crime on factors such as the legal and education system, but lays the responsibility for solving the problem on the shoulders of the individual (victim) personally. It is argued that extending the "blame the system" perspective may diminish the individual feelings of self-determination so necessary for empowerment.

Empowerment is one of the most crucial and highly valued benefits that members can attain by participating in self-help groups and organizations. Empowerment can be described as the process of increasing personal, interpersonal and political power thus enabling individuals or collectives to improve their life situation.

Personal empowerment increases energy, motivation, effective coping, problem-solving skills, decision-making power, self-esteem, self-sufficiency and self-determination. Collective efforts to fight the discrimination against and oppression of the

majority represent the social and political empowerment in self-help organizations. Types of action include:

- Self-help groups that focus on strengthening family functioning and structure;
- Self-help organizations founded by women;
- Self-help special interest groups that share a common experience, concern or interest,
- Self-help groups that seek social change and the mobilization of individual and community resources; and
- Neighbourhood-based groups for community development.

Community health issues

The process of change being experienced in South Africa has once again focused attention sharply on the extent and quality of the community services provided in various fields by the government and by private and other organizations to improve the quality of life of all people, especially those who are poor, deprived and disadvantaged. However, little attention is given to the relevance of research or the ways in which research might inform policy makers and decision makers on the relevance, quality and impact of these community services. Authoritative research and information on existing services at a national, regional and local level are essential for effective planning or policy formulation, for the effective integration of services and for making choices about prioritizing the demands on the limited available human, institutional and financial resources. Although some energy has been devoted to research on some of these services, there is an urgent need for a coherent picture of the strengths and weaknesses of many community services and especially of the impact of these services.

- A technique has been developed for the assessment of health services, aimed at establishing these strengths and weaknesses and at providing guidelines for the improvement of the services. The assessment is based on the strengths, weaknesses and improvement strategies for health programmes, as laid down by the WHO. The specific aspects

of health services that the technique addresses include the organization and structure of the service, the monitoring and evaluation of its functions, and the selection, training, functions, support, supervision and working conditions of the various levels of personnel.

The methods used are of both a qualitative and a quantitative nature and include questionnaires and interview schedules which can be administered according to the needs of a specific health service.

The opinion questionnaires are used for personnel who are not directly involved in a specific health service, but who are involved at other levels (for instance in the training or selection of health personnel) or who are dependant on the service. These questionnaires are suitable for personal or telephone interviews and for postal surveys.

The interview schedules are used when interviewing personnel who are directly involved in a health service. Interviews are conducted either on a one-to-one basis or in focus groups. The survey instruments are adapted to the specific needs of a particular service.

Feedback of the findings is given by means of an oral and written report and includes suggestions for strategies to improve the service.

- The HSRC has developed a technique for the formative evaluation of health guidance (education) material which can be adapted for printed material, pictorial media and the electronic media (radio, television, films and videos). For all material the effect of the media product on the target group is investigated in terms of the following factors: its ability to attract attention, its comprehensibility, how well it can be recalled, the credibility of the source and message, its acceptability, the effect of the message and the effectiveness of the production elements. The readability of the printed material is evaluated by means of readability tests. The pictorial media are also evaluated in terms of the function of visual presentations whereas the evaluation of the electronic

media takes into account factors such as the presentation and technical variables, the organization of content and subject matter and performer characteristics.

The survey instruments include questionnaires and interview schedules. These are adapted to suit individual media products. The techniques used for data gathering include focus group interviews, individual in-depth interviews, self-administered questionnaires, gatekeeper reviews and the use of the Programme Evaluation Analysis Computer (PEAC) system. These are used in the combination best suited for a particular subject and target group.

Verbal and written reporting includes a summary of the results of the survey as well as recommendations for the improvement of the media product.

- A technique has also been developed by the HSRC for the development and evaluation of health education programmes. The technique includes the following elements: needs assessment, process evaluation (including formative evaluation and monitoring) and outcome evaluation. The technique is based on community participation throughout.

In the needs assessment stage the target group is convened and the characteristics of the target group are examined, for instance the group's demographic factors; knowledge, attitudes, beliefs, practices regarding the health education subject; culture (norms and values); use of and preference for particular means of communication; the ability to process information (including functional literacy and listening skills). Existing materials (if available) are examined in terms of subject matter, production techniques and relevance for the target group in order to make recommendations regarding their use and/or adaptations to and the development of new material.

During process evaluation the extent to which the delivery goals of the programme are being met is assessed. Intervention and evaluation issues are systematically

identified and resolved by researching the interventions actually delivered, the difference these interventions make, and the intervention variations found to be the most effective ones. When long-term intervention is carried out, measurements are done at intervals to ensure that the intervention is undertaken by the most suitable people, to the proper target group, in the ways most suitable to the group and at the optimal time. Monitoring of the programme is performed on an ongoing basis.

During the outcome evaluation the consequences of the programme are examined in terms of specific indicators. Then recommendations are made for the improvement and/or expansion of the programme.

Appropriate techniques for the collection of qualitative and quantitative data have been developed for the different stages of the evaluation. The techniques used include questionnaires (self-administered, postal surveys), interview schedules (focus groups and individually), direct observation techniques and monitoring techniques. These techniques are used individually or in combination and are adapted in accordance with the target group and the health education subject.

The abovementioned procedures are adapted to facilitate the process and outcome evaluation of existing health education programmes.

Long-term involvement with indices of socio-economic welfare has enabled researchers in the HSRC to improve the methodology and the calculation of indices of child survival (child health). It is possible to give a comprehensive picture of child health due to the refinement in measuring instruments and the use of an already extensive databank of information from respondents in all geopolitical areas of the country. Because problems in obtaining reliable data on infant mortality are often encountered in the field, it is felt that analyses of the chances of child survival and of health indices

following certain interventions can be used to give a comprehensive picture of the health status of communities. Developments in this regard form part of technology in primary health surveys in the Southern African context.

Development

The development of people requires not only assistance to but also the empowerment of the people at whom the assistance is aimed. Assistance can be of a purely technical (e.g. engineering) nature. Empowerment, however, requires the full participation of the people affected. This participation should be an active process whereby the beneficiaries not only share the benefits but also influence the direction and implementation of the development project.

- The HSRC has developed a technique which treats community participation as an integral part of data collection and analysis. This may be described as the technology of community participation.

Whatever one's philosophy about democracy, the idea of public participation in planning and development is here to stay. One can say that community participation is not only 'fashionable', but has become an essential component of effective planning and development. Human behaviour is increasingly being recognized as an important variable that needs to be taken into consideration in development planning. Therefore, successful development projects are not only technologically but also socially appropriate ones.

There are at least five reasons for encouraging community participation in planning and development. These reasons are the following:

(a) Community participation helps planners and development agencies gain insight into local conditions and the needs and preferences of the local people. This is the pragmatic rationale for community involvement, because without such basic information

to help determine affordability levels and identify community needs and preferences correctly, plans and development actions are unlikely to succeed.

(b) Individuals and groups in the community are more likely to accept and be committed to plans if they have been involved in their preparation. Participation also makes it more probable that the members of the community will regard an improvement/facility as their own, and will therefore maintain it better (i.e. take collective responsibility for it). The absence of community participation may, in fact, lead to the creation of expensive white elephants that are boycotted by the community because its members were not adequately consulted.

(c) It is considered a basic democratic right of people to be involved in matters affecting their own circumstances. This would subscribe to the notion that 'planning/development is for people.'

(d) Community participation is also necessary during project implementation so that information concerning the progress of the project can be provided in order to identify problems and constraints, such as how many and who are the people that benefit from the project.

(e) Direct participation in monitoring and evaluation may also reduce the possibility of the mismanagement of resources by making the development agency's personnel accountable to the community. Project efficiency (determined by the degree to which the community assists in the planning and implementation of a project) and effectiveness (the degree to which the community assumes responsibility for the design and implementation of a project) may therefore be greatly enhanced by

participation, which empowers the community to take over some of the project's managerial and operational responsibilities.

However, it would be naive not to acknowledge that there is simply no easy way of achieving true public participation, and community participation will not always be considered suitable. For example, participation is often unsuited to capital-intensive projects, because the development agency making a large investment in a community may not be willing to relinquish some of its control over the project. Participation also requires flexibility, and may therefore be incompatible with the decision-making culture of bureaucratic and hierarchical organizations. Furthermore, participation tends to be time-consuming and often requires considerable human and organizational skills.

Apart from the abovementioned restrictions on full community participation, there are at least four other major problems that allegedly bedevil participation in planning and development, namely: (a) a lack of public interest; (b) the ignorance of the public; (c) the communication gap between planners/development agencies and the public and (d) undue delays.

These supposed problems can be overcome by adopting a number of basic principles, which include the following:

(a) People need to be directly interested in a decision-making issue and they need to believe that they can influence the outcome.

(b) True participation involves a genuine two-way interchange of views and preferences.

(c) People - irrespective of their educational, social or economic background - cannot make meaningful decisions, either individually or collectively, if they do not know what alternatives are available to them.

(d) Communication with the community should take place in plain language, cutting out theoretical or professional jargon, thereby allowing more people to have a better understanding and therefore be able to contribute to the planning and development process.

(e) Effective community participation depends on (i) mutual trust and (ii) the degree of the client's commitment to truly participatory interaction with the community. No real participation can take place unless both these basic conditions are met.

(f) Communities can act quickly unless they are being confronted with a *fait accompli*. Undue delays are often more the result of incorrect approaches than the inability of the community to make decisions.

(g) Community participation should not only entail indirect participation through representatives, but should also focus on direct participation of the members of the community themselves. This principle means that meetings with community leaders are not always sufficient. The techniques to improve community participation are therefore very important.

No single technique for community participation is likely to be adequate if one needs to consult directly with the members of a community; a combination of several techniques is usually required. In practice this means that two or more of the following will be used in combination:

- information documentation
- exhibitions
- media coverage, audio and visual material
- idea competitions
- referendums
- questionnaire surveys, in-depth and focus group interviews

- public meetings and hearings
- self-help manuals
- planning and development aid
- extension services
- delphi technique applications
- nominal group methods
- workshops.

All these methods are potentially useful, although each has specific limitations and drawbacks. The optimal combination ("mix") of methods for a specific purpose will depend on a proper evaluation of the circumstances surrounding a particular situation and the needs of the client and stakeholders.

Community participation takes many forms and contains procedures which depend on the particular situation. These procedures may entail the following steps (which may not necessarily follow chronologically as indicated here):

(a) Contacting various individuals in the community and having the leaders pointed out, in an attempt to identify organizational affiliations, the complete leadership situation in the community and the role of other organizations

(b) Meetings with all the relevant organizations and leadership structures within (or which operate on behalf of) the community, and negotiating the terms of the planned community participation procedures

(c) Information gathering and feedback by means of two or more of the methods listed above, and the drawing of preliminary conclusions

(d) Meetings with the organizations and leaders to discuss the preliminary conclusions and to revise them if necessary

(e) Feedback to the community to discuss revised conclusions (if any), and meetings/workshops to find

compromises between the preferences of the community and those of the leaders and other organizations, and to reach agreement on the procedures to be followed during implementation

(f) Implementation of the conclusions (in close consultation with the community, leaders and relevant organizations), accompanied by monitoring (the process whereby information is gathered - more or less continuously - on the project's performance in relation to its inputs and objectives), ongoing evaluation (continual analysis of the outputs, effects and development impacts of the project) and feedback

(g) *Ex post* evaluations (analyses of the [overall] outputs, effects and impact of the project after its completion) and feedback to all interested parties.

The HSRC provides advice on and assistance with the selection of the most appropriate combination of methods and their implementation during community participation. Multidisciplinary teams are made up to suit the needs of every particular project, thereby ensuring that the best available pool of knowledge and experience is placed at the disposal of the client and other stakeholders.

Social Impact Assessment (SIA) is a relatively new multidisciplinary field that has been developed in response to the 1969 National Environmental Policy Act (NEPA) of the USA. SIA is an assessment technique complementary to, or an integral part of, Environmental Impact Assessment. It is aimed at the identification and determination of the nature, magnitude and significance of the possible effects or impacts resulting from proposed development actions. In particular SIA is concerned with the effects of development actions on the well-being of the population concerned, and with the accompanying alteration of the social environment.

SIA is generally viewed as anticipatory research for assessing planning needs with regard to technological development and the potential social impacts associated with such development. Central to this process is the identification of mitigation options and the assessment, in advance, of alternative courses of action (forecasting). Ideally, SIA entails employing a systematic approach using sophisticated analytical techniques to determine the direct and indirect effects, as well as the positive and negative impacts accruing to development activities. In addition SIA should facilitate the identification and assessment of new development opportunities that may result from development projects.

Social Impact Assessment incorporates multiple judgment criteria including both time and space scales. Validity is enhanced through the application of quantitative and qualitative research techniques and the triangulation of research methods in order to minimize judgmental biases.

The particular SIA approach adopted by the HSRC team strongly emphasizes integrated resource management. This approach endeavours to promote the effective integration of development actions through a process of negotiated agreement, as well as through the democratization of decision making to benefit all participants and stakeholders.

SIA has the potential for enhancing democratic participation in the policy-making process. There is a growing realization among researchers at the HSRC that SIA should be incorporated at the early stages of project planning and in fact should be part and parcel of the project design. This could assist both planners and implementing agents in ensuring that their actions are people-friendly. Moreover, the incorporation of SIA as an integral part of the planning process could facilitate the establishment of a mediation process whereby the extent and magnitude of socio-economic dislocation could be ameliorated, as well as creating the opportunity for the affected population to influence the course of their own future.

- The Social Impact Assessment technique as developed by the HSRC consists of the following components:

(a) Profiling:

- To identify all stakeholders (agents, beneficiaries, victims) who are at risk/may have an interest in the proposed development
- To elicit from all stakeholder groups their views/opinions on the proposed development, as well as their respective claims, concerns and issues in this regard
- To identify existing interest configurations and to determine the information requirements for adequately addressing a possible conflict of interests

(b) Data collection:

- To determine the number of individuals/households, as well as the range of social categories, groups, institutions and organizations that will be affected by the proposed development
- To identify the nature and extent of the socio-economic impacts associated with the proposed development
- To generate reliable data with the aim of testing the plausibility and relevance of stakeholder claims, concerns and issues

(c) Projections:

- To determine the magnitude and significance of the socio-economic impacts associated with the proposed development on the affected and/or host populations
- To identify alternative development options and positive impacts associated with the proposed development

(d) Assessment:

- To investigate viable mitigation options or alternative development policies, and to compare the anticipated impacts of the alternative options and policies

- To assess which alternative is best in terms of the significance of the socio-economic impacts and the alternative's viability in terms of regional integration
- To identify areas for further research and to augment existing data if necessary

(e) Evaluation:

- To disseminate relevant information to all stakeholder groups by means of draft reports to, and workshops with, recognized representatives
- To seek the opinion of government bodies and public bodies that have special interests/responsibilities with regard to the proposed development
- To facilitate discussion with stakeholder groups in order to generate consensus and to formulate a negotiated agreement

Generally, cognizance is taken in the evaluation of development programmes of the material and the non-material products accruing to projects. Evaluation programmes, however, are often one-off events, narrowly focused on economic and financial returns in order to satisfy the demands of sponsors or donor agencies, while little attention is given to the social dimension of development projects.

Social development is concerned with the degree of integration of a project's material products with non-material (qualitative) processes such as the following:

- critical and active local participation and collective effort
- democratic organization and collective responsibility
- critical consciousness/awareness and self-confidence
- local initiative, motivation and innovation
- efficient local institutions and leadership
- self-reliance and self-determination
- internal cohesion and group solidarity.

The HSRC is currently reframing its existing Social Development Evaluation Programme (SDEP) which is specifically designed for the assessment of social development programmes with

diversified project activities. The SDEP aims at incorporating a multidisciplinary and multimethod technique, and with its emphasis on proportionate accuracy, the SDEP is designed to be cost-effective and time-saving.

The SDEP addresses the following project performance and impact issues:

- expressed beneficiary needs
- programme objectives
- beneficiary participation
- intermediate effects
- differential impact
- project sustainability.

The SDEP is particularly well-equipped for the assessment of the intermediate effects and differential social impacts of a development programme/project, and provides a valuable tool for assessing the following:

- contextual constraints: systems dependence/resistance
- differential impact: socio-economic differentiation and social strata
- distribution: number and range (spatial/social) of beneficiaries
- access/equity bias: accessibility; affordability; adequacy
- internalization: critical awareness; motivation; self-confidence
- collective effort: group solidarity; self-reliance
- legitimacy: appropriate levels of local ownership and control
- continuation: effective local leadership and local organization.

The population projection technique is an essential tool for planning the future needs in nearly every aspect of human endeavour. At the macrolevel, facilities for school enrolment, entrants into the labour market, old-age pensioners and military training, can be planned and constructed. At a regional level the growth of local populations, e.g. in towns and suburbs, should be

predicted in order to plan the extension of services such as water supply, sewerage, electricity supply, roads and public transport. Business and industry use population projections to determine the volume of production and the location of markets. Projections are made for national population growth as well as for population growth in smaller geographical areas. Projections are also made for special categories of people, e.g. school enrolment in certain geographical areas, entrants to universities, prison populations, the number of hospital beds needed, and target populations for specific media campaigns.

Various methods have been developed for making projections for different types of populations. The demographer knows which method should be used for a specific population. The main activities when making a projection are the analysis of all the relevant data, the study of historical trends and factors related to these trends, and the adjustment of defective data. Clearly the construction of population projections is the result of intensive research on the subjects.

With the advent of computer software packages for the use of population projections, anybody who can operate a PC can conduct these projections. This factor should always be kept in mind by the user of such data. If the user is not certain of the quality of specific projections, a knowledgeable demographer should be consulted.

Social interaction

The success and even survival of any organization, be it a business or a political, non-profit or government institution, depend largely on effective internal communication within the organization and with stakeholders on the outside. The need to diagnose and remedy weak links in the communication system, especially in a socially, culturally and economically highly stratified society, is therefore obvious. Decision makers who depend on public opinion, consumer attitudes and reactions, and

the effective transfer of messages, have at their disposal sophisticated technology to obtain the required information.

Continuous Response Measurement (CONREM) is a tool for measuring immediate second-by-second reactions to audiovisual material among specific target audiences. CONREM can provide valuable information to anyone involved in producing or displaying audiovisual products. This is especially the case if there is a need for feedback from prospective target audiences about matters such as their general liking for the product, specific preferences regarding scenes, situations, techniques or actors featured in the product, or their understanding of the text or visuals. Small groups of people (maximum 25 at a time) are shown a video of an audiovisual product, such as a TV programme or advertisement, and their reactions are monitored from second to second by means of a microcomputer system. These reactions are immediately transformed into a graph that shows visually how the group as a whole reacted at every point in the programme or advertisement.

The CONREM apparatus consists of 25 hand units that each transmit a uniquely coded radio signal (the reactions of the audience members) to a receiver linked to a small portable IBM-compatible laptop computer. These signals are shown as a graph on the computer monitor, and are simultaneously stored as data that can be printed out. Besides the continuous recording of responses in the form of a quantitative graph on the laptop PC, additional qualitative information can be obtained by means of group discussions. Questionnaires can also be used to obtain individual responses or opinions from audience members. The presentation of the findings depends on the client's requirements. Usually the findings are presented in the form of a report containing not only a written account of the aim of the study, the specific methods used and a summary of the most important results, but also the CONREM graph and, if applicable, the charts describing the questionnaire data and a write-up of the group discussions.

CONREM can give an immediate idea of an audiovisual product's strong and weak points (for example which section was most popular, or which parts the audience did not understand). This method, together with focus group interviews and questionnaires, can be used to test the effectiveness of established TV programmes or advertisements. It can also be used on pilot TV programmes as an early warning regarding viewers' probable reactions to a new series. This pretesting of prototype products, also known as formative evaluation research, can help producers or manufacturers to make more effective final products and also prevent unnecessary expenditure on unpopular or ineffective audiovisual material.

Communication audit is a scientifically based technique to analyze the internal and external communication of an organization. This technique is aimed at providing a description of the organization's communication needs, communication policy and communication practices. The range and depth of a communication audit are largely determined by the size and complexity of the organization as well as by the specific communication needs and requirements within the organization. The most effective way of conducting a communication audit is to engage the services of a consultant. This is not an absolute requirement since in-house personnel can be taught to do it. However, there are various merits to enlisting the services of a consultant. The advantages include the experience gained from working with other organizations, the undivided attention that can be given to the organization and the relative objectivity of the consultant. Experience has found that the most effective communication audit is one in which the consultant and personnel from the organization combine forces.

Content analysis is a technique developed to study systematically and objectively the contents and characteristics of communication. The HSRC offers a training module in content analysis which can be adapted to a client's specific needs. Content analysis can be used by anyone who is interested in

obtaining a reliable and valid overview of what is being communicated (usually by the mass media) to the public or to a segment of the public. This would in the first place include political, business or other decision makers who would like to know what the media's reaction is to their own actions or to current events. The results of a content analysis could in such cases be used to help plan future actions. The method can also be useful to people who need to keep abreast of the trends in the media coverage of specific topics. Similarly, knowledge of the public agenda (those topics that the public consider as most important with regard to a particular event) set by the mass media could be crucial to public figures such as candidates seeking election to public office. Content analysis can yield information to organizations and persons who enjoy frequent media coverage and who are concerned about their media image. Finally, content analysis can help decision makers and academics who are concerned with long-term social planning that has to take into account the interaction between media content and trends in society.

The process of change in South Africa has once again focused attention sharply on the extent and quality of community services that are provided in various fields by the government and by private and other organizations to improve the quality of life of all people, especially those who are poor, deprived and disadvantaged. However, little attention is given to the relevance of techniques by which research might inform policy makers and decision makers on the relevance, quality and impact of these community services. Authoritative information on the existing services at a national, regional and local level is essential for effective planning, policy formation, the effective integration of services and the choices made about prioritizing the demands on limited available human, institutional and financial resources. Although some energy has been devoted to these services, there is an urgent need to provide a coherent picture of the strength

and weaknesses of many community services and especially of the impact of these services.

Political and constitutional issues

The HSRC's objectives with regard to the evolution of an accepted political system, political empowerment and optimal sociopolitical stability require the development of techniques to monitor and analyze public opinion, conflict and violence.

South Africa, like many other countries in the world today, is undergoing constitutional adaptation and renewal. In the process of constitutional development, attention is frequently given to the experiences that other countries have with specific mechanisms. This entails investigating the constitutions of different governments in order to examine and possibly learn from their functioning. So far the constitutions of other countries have been available only in document form and consequently, comparing the laws of various constitutions has been laborious and time-consuming.

The HSRC's Centre for Constitutional Analysis has developed a technique that analyzes all democratic constitutions by means of a comprehensive questionnaire and that captures the data on computer. Experts in political science and constitutional law have completed the questionnaires. Several foreign experts and more than 30 local researchers have been involved part time in the project. The questionnaire contains more than 1 000 questions compiled by constitutional experts. Each constitution is therefore analyzed on the basis of uniform questions, and then the data obtained in this way are captured on computer. Consequently, users can gain easy access through their computers to information that was formerly inaccessible. The database as well as the text of each constitution are filed on compact disk. This means that the user can shift directly from a specific question to the text of the constitution in order to determine how a particular section is worded. The questions used as the basis for analyzing the constitutions cover a wide

variety of fields, including the composition of the parliament and cabinet, the powers of regional and local governments, the protection of human rights and the competencies of the courts. The technique therefore greatly facilitates the comparison of constitutions. It not only has advantages for students and researchers, but will also be indispensable to countries undergoing constitutional reform. The product will be marketed locally and internationally on CD ROM.

South Africa has experienced unprecedented levels of peaceful and violent forms of protest during the last two decades. In fact, the level of violence during this period was so high that South Africa is generally regarded as one of the most violent societies in the world today. Since October 1984 more than 10 000 people lost their lives during incidents of political violence. An important characteristic of violent and non-violent forms of protest in South Africa is the extent to which political sentiments impel political violence. The complexity of protest and violence makes it imperative to analyze forms of protest in South Africa. Such analyses will contribute to a better understanding of the characteristics and dynamics which underlie these forms of collective action.

With a view to gaining a better understanding of conflict phenomena, an extensive measuring instrument was developed by the Centre for Conflict Analysis in collaboration with colleagues in the United States. This instrument has recorded in great detail the characteristics of each and every incident of collective action — violent and non-violent — in South Africa since 1970. Information is recorded on more than 60 variables, which include the location in time and space, the duration of, participants in and perceived causes of the event. Another version of this measuring instrument has been used in a study of collective action in the US since the 1950s.

Labour unrest can hardly be divorced from other forms of political protest in South Africa. This is especially true for the period before 1990 when black political organizations were

banned by the South African Government. Since labour unions provided the only legal way that blacks in South Africa could formally organize, black labour unions played a major role as instruments for addressing political issues. The unbanning in 1990 of organizations which primarily cater for the political aspirations of blacks in South Africa may undermine the political role of labour unions.

In order to trace the changes in the dynamics of labour unrest in South Africa, the Centre for Conflict Analysis of the HSRC has developed another extensive measuring instrument. The study underlying this instrument supplements the Centre's research into other forms of collective action referred to above. The labour unrest instrument records information on more than 60 variables, including the company and industry in which the strike or work stoppage occurred, the date when it occurred, the number of workers involved and the cause of the strike or work stoppage.

Conclusion

Human society is complex and multifaceted and so too are the problems that ensue when essential societal structures and systems break down or malfunction. The social sciences have taken great strides in unravelling the intricacies of social dynamics. Scientific knowledge alone, however, is not enough to remedy the ailments of society. It has to be converted into appropriate problem-solving procedures and techniques and these in turn should be applied with great sensitivity and the active participation of the people affected. These are prerequisites for the development of viable social sciences technology aimed at sustainable solutions for the many ills in society, such as alcoholism and drug-related problems, crime, family disintegration, underdevelopment, and political, social and labour-related conflicts.

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5

FUTURE PERSPECTIVES

R.J. Prinsloo

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Introduction

The purpose of this book is amongst other things to introduce the concept of human science technology (HST) to the South African academic community, decision makers and public.

This does not imply that "technology" in the human sciences is a novel concept. Kenneth Prewitt (1981), at the time the President of the Social Science Research Council in New York, used it as early as 1980 in his annual report

> numerous well-established industries now market technologies that are derived from social science research: demographic projections, programmed language instruction, standardized educational and psychological testing, behaviour modification, man-machine system design, political polling, consumer research and market testing and management consulting.

Reiss, in Smelser (1986) *Behaviour and Social Science: fifty years of discovery* referred to it as "social and behavioural science inventions", while Gerstein in the same book used the term "technical inventions". Elsewhere in his book Reiss referred to "the behavioural and social sciences and their technologies".

Reiss in Smelser (1986) singles out the following four "social inventions" — or HST — as the ones that have had the greatest impact on society, namely: human testing, sample surveys, quality control methods and cohort analysis. These should be seen against Ogburn's list of five social inventions drawn up in 1934, namely: the minimum wage law, the juvenile court, Esperanto, instalment selling and group insurance. The "hard" technologies that Ogburn in 1934 regarded as having had major influences on society were the ship, the airplane, the internal combustion engine and the elevator — without the elevator, high-rise buildings would not have been possible (Smelser, 1986).

Reiss goes on to make the important observation that, relative to the natural sciences, the lower scientific prestige of the behavioural and social sciences rests in part on their not studying

the social impact of their inventions (Smelser, 1986). Reiss's observation suggests the possibility that the social sciences have been so obsessed with analyzing the consequences of the "hard" technologies that they never realized they were themselves producing HST, which in turn was exerting major influences on society.

As far as South African HST is concerned, the previous chapters have indicated that local social scientists have made major contributions to,in particular, two of the technologies that Reiss mentions, namely, human testing and sample surveys. South African psychometric and edumetric tests compare favourably with those available elsewhere in the world, in respect of novel tests and also of adaptations of well-known overseas instruments. Contributions to sample surveys have included South African breakthroughs such as aerial photography, which was used extensively during the 1991 census, as well as new methods of surveying income and expenditure.

Classification of technologies

Although scientific change often occurs through strong advances in a single established discipline, today new knowledge appears with increasing frequency at the boundaries of disciplines. It is in the interaction between domains of knowledge that many of the most productive areas of research are found.

To complicate matters, the boundaries between science and technology have become increasingly blurred. Activities of a particular researcher may often involve science as well as technology. Some disciplines such as engineering, medicine and agriculture might even be more technological than scientific.

Engelbrecht (1991) provides a useful framework for distinguishing between science and technology. He states that the important question to ask is not *what* is being done by someone involved in science and technology but *why* it is being

done. If the aim is to understand the world, he calls it science; if it is to *control* the world or society, he calls it technology.

Engelbrecht (1991) bases his reasoning on the fact that the Greek word *techné* refers to weaving and historically, people have worked in the sphere of practical skills in producing some tangible product. The Latin word *scientia* derives from cutting and drawing distinctions, whereas the German word *Wissenschaft* refers to having insight and to the cognitive act of "understanding". Activities that have as their goal a particular product or even a certain state of affairs may broadly be designated as "technology". (Note that the product in such cases need not be tangible.)

The following diagram (Figure 1) of Engelbrecht's (1991) provides a useful illustration of the framework and the linkages between the various components. Radnitzky (1991) also draws attention to the fact that technologies can be classified into different categories according to the theoretical framework underlying the technology concerned. This links up with Engelbrecht's views about the interdependence of technologies.

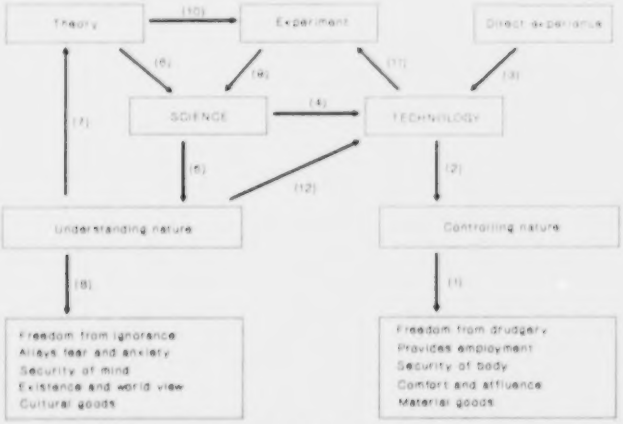

FIGURE 1: THE RELATION BETWEEN SCIENCE AND TECHNOLOGY

According to Radnitzky (1991) a major distinction would be, first, whether the technology was of an artisan type, based on observed correlations that could not be explained. Engelbrecht defines this type of technology as technology built on direct experience. The Bessemer technology in steel production is a typical example, because it was not based on a theory that could explain why it failed in certain cases. Because of the relatively poor development of theory building in the social sciences, it can be speculated that a large percentage of HST would be of the artisan type.

A second classification of technologies would be based on science, implying that the general principles could be explained in terms of a theory. A classic example is that of the development of nuclear technology from atomic theory (Radnitzky, 1991) or, in the case of the social sciences, mental tests based on item response theory which is a statistical theory of mental test scores (Lord and Novick, 1974).

Frank Press, President of the National Academy of Sciences of the USA (1992), underlined the importance of R&D when he said during a colloquium on S&T policy in Washington that science would drive technology. He also said that spin-offs will have to be gained from research not only in areas that have still undiscovered applications, but also in those that have obvious commercial and industrial applications.

Technology can also be distinguished from art since, in principle, anyone can learn the expertise pertaining to a technology but, by contrast, art typically depends on the uniqueness of the artist's personality.

Radnitzky states that it has become common practice to think of technology primarily in terms of engineering technologies. The concept of technology, however, also makes provision for a typological description of technologies such as medical technologies, social technologies, etc. It is based on an analysis of the goals or values to be realized by means of the technology concerned. Research methodology can, for instance, be seen as a

technology that facilitates the advancement of knowledge (Radnitzky, 1991).

According to Mauer (1992), HST can also be classified according to the extent that expert knowledge is needed to use the specific technology. As can be seen from Figure 2, certain technologies need a great deal of expertise whilst others hardly need any. The more complicated techniques will generally be the most expensive ones to apply.

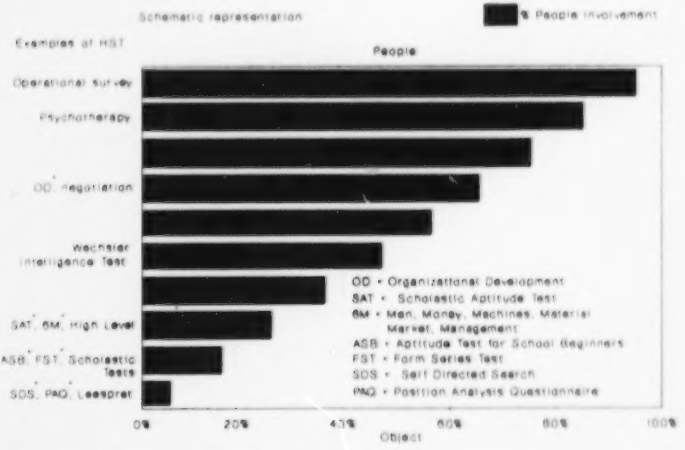

FIGURE 2: DEVELOPMENT OF HUMAN SCIENCES TECHNOLOGY (HST)

The value of HST in socio-economic development

Pouris (1991) claims that S&T is the most important factor in socio-economic development affecting international competitiveness, economic growth, productivity and employment. He also refers to Solow who won the Nobel Prize for Economics in 1987 for his studies on the factors underlying the doubling of work in gross output per hour that the USA enjoyed between 1909 and 1949. Solow showed that technology directly affects the creation of wealth. Of all the factors that might

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have been responsible (e.g. capital output rates, rate of savings or the rate of growth in the work force) Solow estimated that 88 % of the economic growth was attributable to "technical change in the broadest sense".

Pouris (1991) also argues that technology is the major factor responsible for improvements in productivity. Since World War II new technology has been responsible for nearly half of all increases in productivity, more so than those due to increased capital, better education, or any other single factor. One should, naturally, not be so naïve as to think that HST would have an equivalent impact, but on the other hand one should once again heed Reiss's observation that HST has had a greater impact than scientists in this field have themselves realized.

The impact of S&T development on the economic growth of a country remains somewhat nebulous. It has been pointed out that adequate financial provisioning for science requires a progressing economy, not necessarily the other way round. In other words, it is difficult to say which comes first — a strong science leading to economic prosperity or economic prosperity leading to a strong science. It is more likely a combination of both factors interacting one upon the other.

The capacity of the human sciences in South Africa to produce technology

Undisputed knowledge ("empirical regularities" [Prewitt, 1981]) in the human sciences is more difficult to acquire and to establish than in the natural sciences. Its translation into technology is a far more cumbersome and uncertain undertaking.

However, important issues need to be addressed by the human sciences in South Africa. These include upgrading the human sciences, improving the quality of students who enrol for studies in the human sciences and enhancing the quality of the training they receive. The current situation suggests that the human sciences might be attracting too many students and that too many human science students are of very average ability.

The quality of research done in the human sciences should demonstrate to the public that the country needs such scientists to help solve our pressing problems — which, incidentally are mostly human problems and therefore ought to be addressed by social scientists. However, present day problems are so complex that no single discipline can possibly hope to solve them all. A multidisciplinary approach is essential. Such an approach does not necessarily imply co-operation with other social scientists only, but also co-operation with scientists from other science cultures such as the natural sciences and the medical sciences.

Prospective students ought to be informed about the possibilities of combining subjects from e.g. the natural as well as the human sciences in their curricula. The present barriers between the human sciences and the natural and other sciences should be lowered, and a flow of students among the various faculties encouraged. Marais (1990) observes that social scientists in the USA are involved in multidisciplinary projects with natural scientists much more frequently than is the case in South Africa. This suggests that the social sciences in the USA might be more readily accepted by the natural and other science cultures than they are in South Africa. Unfortunately, the lowering of the barriers between faculties will be an extremely difficult manoeuvre. Nevertheless there can be no doubt about the positive results that can be obtained by making it easier for students to combine subjects from different faculties. If at the same time the curricula of the human sciences (and perhaps, more specifically, the humanities) are adapted to include more skills that can be used in industry, such as problem-solving ability, logical reasoning and analytical thinking, this will ensure that these students will find it easier to obtain employment because of a broader background.

Garbers (1988) also referred to the problem of numeracy in the human sciences when he remarked

> there is an urgent need for human sciences researchers to master more sophisticated numerical skills. The reason

> is obvious. The multivariate character of all human and social phenomena can be ordered by means of qualitative methods, but more particularly by multivariate statistical techniques (p.142).

Generally speaking, the upgrading of the mathematical and statistical skills of researchers in the human sciences to more sophisticated levels will have to receive attention if progress is to be made.

The role of centres of excellence in the creation of HST

Research cited by Jackson and Rushton (1987) refers to a phenomenon which indicates that "evocative environments" seem to attract brilliant people. The better the research that an institution undertakes, and the more proficient its personnel, the better are its chances of attracting other creative persons. Evocative environments apparently do not often exist in the human sciences; they have to be created, properly funded and staffed by creative people under dynamic leadership.

There are various successful models that could be utilized to produce such centres. Mention is made of two kinds, namely, centres for advanced study in the humanities and social sciences, and centres for collaborative research.

Centres for advanced study provide an opportunity for a group of talented scientists in the human sciences and sometimes a few from selected disciplines in the natural and medical sciences to spend a year together in an evocative environment condusive to the development of new technologies, theories, models and the undertaking of high level research.

Collaborative research centres are usually created by pooling the research power and infrastructural resources of a few universities, to work on a specific practical problem in the human sciences with adequate funding guaranteed for a couple of years.

A complicating factor is the fact that human problems are so much part of everyday life that they are not regarded as provocative and challenging enough for research. Such a

situation might be further reinforced by our education system, for example, in the research orientation of teaching the natural sciences which involves experiments to prove theories, development of new technology in comparison with teaching history, languages, etc. Students in the human sciences should be exposed to training in research at an earlier stage — preferably from the first year onwards. The present system of introducing research rather abruptly at the master's level — without proper training — is not the best way to inculcate an interest in science and technology.

HST and the implementation of research findings

Scientific findings may often take from ten to 20 years to be implemented (Heller, 1986). There is evidence that this period might in some cases have been even longer in the human sciences. Dempster (1988) in the *American Psychologist* refers to the so-called spacing effect, in other words, the finding that for a given amount of study time, spaced presentations (regular review of study material over a fairly long period) yield substantially better learning than do massed presentations (crammed sessions of all the material over a short period). This phenomenon is one of the most dependable and replicable findings in experimental psychology. It was first discovered by Ebbinghaus in 1885 (Dempster, 1988) but is nevertheless hardly ever used or referred to by educators. It is obvious that something needs to be done to shorten the "Dempster effect" or the period between discovery and the implementation of the research findings in the human sciences. An implicit problem in Dempster's statement is that a profusion of solid findings in the human sciences may not be known to people who would be keen to implement the results.

Furthermore, knowledge in the human sciences is generally speaking not likely to be so compelling or authoritative that it leads inevitably to implementation. Knowledge in the human

sciences does not easily lend itself to conversion into replicable technologies (Weiss 1979).

Caplan (1990) also warns that the "better mouse-trap" theory of utilization usually does not work. (The "better mouse-trap" theory maintains that if you build a better mouse-trap the world will beat a path to your door.) The hard fact is that there is no guarantee that this will happen. A further constraint is that the world of the researcher and the world of the user are separate worlds with different and conflicting values that have to be reconciled. In addition, the organizational climate of institutions might be such that new knowledge cannot be implemented without creating serious problems. Implementation should be done cautiously and requires knowledge of the inner workings of the organization.

The human sciences also have to cope with the D.I.Y.S.S.S. — or the "do-it-yourself social science syndrome" (Heller, 1986). All people consider themselves experts in the human sciences. Research findings originating from the natural sciences are therefore more readily implemented than findings from the human sciences. Kenneth Prewitt (1981) said:

> Ironically, the social sciences seldom get full credit for their theoretical accomplishments, because the discoveries, once labelled, are quickly absorbed into conventional wisdom. This is easily demonstrated: note the number of so-called social science concepts common to our vocabulary: Human capital, gross national product, identity crises, span of control, the unconscious, price elasticity, acculturation, political party identification reference group, externalities. Obviously, the phenomena revealed through such concepts existed, prior to the relevant research, just as DNA, quarks and the source of the Nile existed prior to their discovery. Yet concepts generated through research are discoveries that make phenomena intelligible and accessible that previously were inaccurately or incompletely understood (Editorial: Science).

There is evidence, however, that the period between discovery and application has in the meantime been dramatically shortened, especially as far as the "hard" technologies are concerned and that the Japanese are twice as fast as the USA in bringing new technology to the market (AAAS, 1992).

It is also estimated that the first competitor to bring a new product to the market generally captures 80 % of the market (AAAS, 1992). Researchers in the human sciences will have to take note of this and realise that they are in the technology business themselves. As soon as they realise this, there is likely to be an improvement in the implementation of research findings and an increase in technology development in these sciences.

Paradigm shifts

It is not uncommon for well-known companies, who dominated the international markets for years and whose products may have been household names, to find themselves suddenly in trouble. Mention can be made of just two such incidents (Pistorius, 1992): Some years ago National Cash Registers Company (NCR) was forced to fire 20 000 of its employees and to write off stock to the value of $140 000 000. What went wrong? It would appear that, although the company sold mechanical electrical registers for years, they were out of touch with the modern technological developments that resulted in the manufacture of electronic equipment by their competitors, which rendered NCR's range of products obsolete.

The same happened to the manufacturers of Swiss watches. Switzerland dominated the manufacture and marketing of watches for 60 years but they had to lay off 77 % of their work force (50 000 people) when their share of the market dropped to 10 % with the introduction of quartz watches manufactured in Japan. They had been aware of the development of quartz watches but they never thought that there might be a market for them. This was a serious error of judgment.

In order to form a better picture of what went wrong, it might be instructive to look at the life cycle of just about any product. This cycle can be represented by the well known S-shape curve in Figure 3 (Pistorius, 1992). The typical sales pattern according to the curve is for it to set off at a slow pace, then gain momentum and after a period, level out to an asymptote.

When the product reaches an asymptote, the manufacturers usually endeavour to boost the sales by trying to improve the quality of the product. They sometimes manage to extend its life span by doing so, as pointed out in Figure 3.

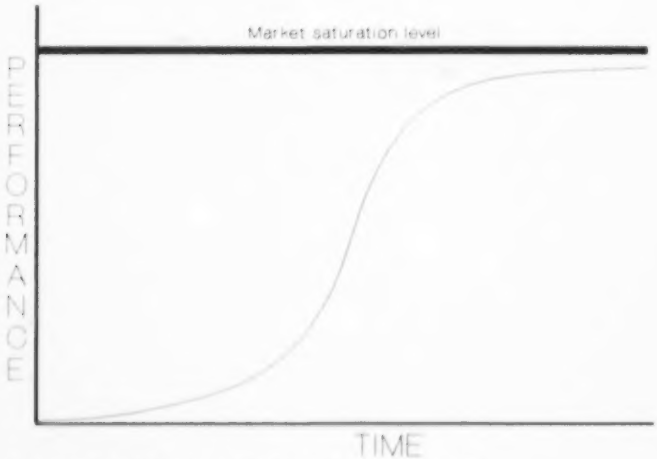


FIGURE 3: TYPICAL PRODUCT CYCLE (Pistorius, 1992)

An illustration of what happens when an innovative new product hits the market is also seen in Figure 4.

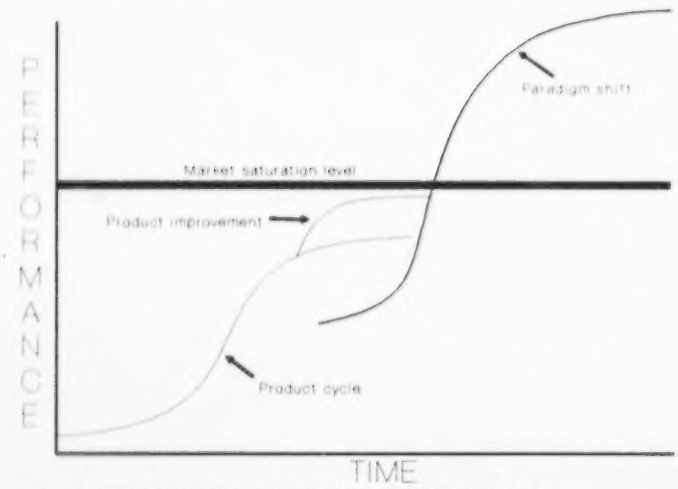


FIGURE 4: PRODUCT CYCLE, PRODUCT IMPROVEMENT AND PARADIGM SHIFT (Pistorius, 1992)

The examples of electronic cash registers and quartz watches being replaced by innovative new products are illustrations of a phenomenon that is known as a paradigm shift.

A paradigm shift occurs when new technology which is developed is so radically new in principle that it completely changes all existing rules, so that all parties have to start from scratch again (Pistorius, 1992). In terms of HST, a paradigm shift can be illustrated by paper and pencil tests of psychological traits being replaced by computerized tests and these in turn being replaced by computerized adaptive tests.

Computerized adaptive tests are based on modern item response theory (Lord and Novick, (1974)), which is more powerful than traditional classical test theory and could therefore open the door for technological innovation. From a set of items for which the item response model holds each individual taking a test can be given a subset of different items, but the test results would be comparable because the scores for different subsets of items are on the same scale. Item response theory is

also an illustration of HST based on an elegant mathematical model.

Technological innovation

What can industry do to stay ahead of new developments? According to a CSIR report (1991) the traditional science-push model (Figure 5), has been replaced by the more complicated but more realistic chain-linked model (Figure 6), which emphasizes that technological innovation is a process characterized by many and continuous interactions and feedback. It is not a single operation.

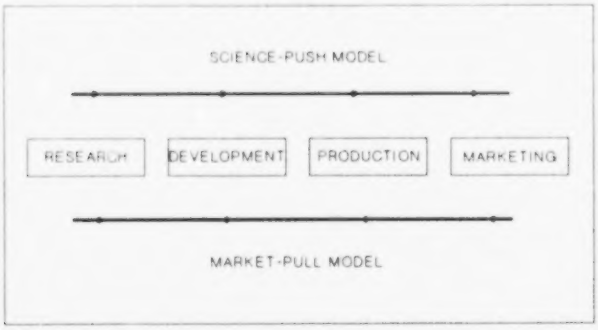
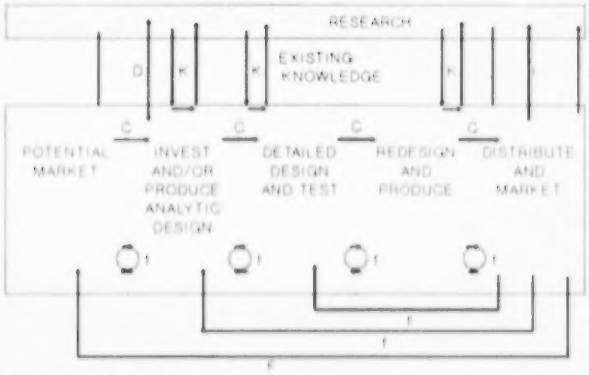


FIGURE 5 LINEAR MODELS OF TECHNOLOGICAL INNOVATION



C: central chain of innovation
f: feedback loops
F: strong feedback loop
K: links through existing knowledge and return
D: direct link between research and innovation/design
I: support of scientific research by instruments, machines, technology, procedures
S: support of direct research and of monitoring underlying sciences

FIGURE 6: CHAIN-LINKED MODEL OF TECHNOLOGICAL INNOVATION

Pistorius (1992) says that it is easier to accommodate change if it is accepted that the normal state of affairs is one of rapid change and turbulence rather than one of slow incremental change.

Sudden paradigm shifts should be avoided by creating a climate for technological innovation that is based on ongoing discovery and market exploitation. A "discovery" can be defined as the creation of new ideas, processes, or services while "innovation" could be described as new products, processes and services that are accepted successfully by the markets. In other words, it can be said that innovation is equal to discovery as well as market exploitation.

Economists estimate that 50-70% of economic growth can be attributed to innovation. The figure for South Africa is only 20% (Pistorius, 1992).

For producers of technology to survive, it is essentail to manage innovation successfully. One should never wait for the inevitable to happen. The future should be anticipated. New

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ideas should continuously be monitored and new products tried out. Opportunities should be identified, problems should be solved, prototype solutions should be tried out, and products should be developed, marketed commercially and diffused in the markets.

Technology transfer

Tisdell (1981) says that most of the ideas used in innovations by firms come from outside their firm. The movement of individuals between organizations is the greatest single source of transfer (20,5%). Education plus literature accounted for 18,5%, personal contacts 9%, visits abroad 7% and conferences 2,5%.

Tisdell (1981, p.91) goes on to say:

> Possibly the majority of innovations arise from a little understood process of movement of people: through small firms being acquired by larger firms or licensing larger firms or acquiring licences from them: by staff leaving one company and joining another and also through the so-called spin-off process where an individual leaves a large company, university or laboratory (some times because he cannot get his ideas implemented) to set up his own business, perhaps to succeed spectacularly, perhaps to fail and possibly in either event to sell out to a larger firm.

In the case of technology being transferred from one country to another, and especially in the case of third world countries, there should be a minimum of scientific expertise at the receiving end (Gaillard, 1991). Furthermore much of the knowledge and technology conceived in the developed countries cannot be applied directly to the developing countries without modification and adaptation. There are always problems connected to knowledge appropriation and technology transfer that can only be solved through on-site science — in other words, on-site scientists (Gaillard, 1991).

Management of technology

The complexity of the process of managing technology has up to now been neglected and its importance underestimated.

This should no longer be the case. World-renowned institutions such as the Massachusetts Institute of Technology (MIT) has introduced a master's degree in Technology Management (TM). Some South African universities' engineering faculties are following suit with the introduction of under-graduate courses in TM. The main components of TM would be

- the analysis of technology
- the evaluation of the impact of technology on the markets and society
- the management of R&D and the various research projects in terms of R&D
- a well-defined and clear technology policy
- The chalienges of the 90's and the 21st century require TM to receive more attention if the needs of the country are to be met.

Ideological issues

Although ideological issues are usually interpreted to mean the government policy that decides which research should be funded, as well as the problems that arise when doing research sponsored by or involving a government department (especially when the findings were or could be critical of government policies and practices), the term has other connotations. For instance, "scientism" as such can be interpreted as an ideology professing to be objective, always pursuing the truth and pointing the way to happiness. It is sometimes said that the current ideology of science and technology is an ideology of salvation. A large portion of the public believe that the world's problems can be solved by scientists and technological innovation.

On the other hand, fears of a technocratic take-over of the public's lives should be counteracted by bringing technocratic decision-making back into public debate. It is essential that scientists and technologists be involved in this public debate, and that it addresses important issues of the social values and norms which play a role in technocratic decision-making.

Ethical considerations

Hans Lenk (1991) claims that the ethical and moral questions relating to science and technology are usually problems of responsibility. These responsibilities can be grouped under three headings, namely: action responsibility, role and task responsibility and universal and moral responsibility.

Action responsibility means accepting responsibility for the results and consequences of one's own actions. It also refers to the question of accountability — frequently in respect of negative examples, as for instance the quality of technological products and safety. Negative causal responsibility is also emphasized. Professionals are, for example, responsible for ensuring high standards in their work and for avoiding mistakes in technological functioning, failures, poor quality work, etc.

Accountability may also refer to what is sometimes called political correctness. It is a complex issue with different meanings, but according to one interpretation boils down to the fact that certain research topics could injure the feelings of certain groups and should be avoided. The human sciences are vulnerable here, but so are disciplines such as human genetics projects. Typical topics, to name but a few, would be nature versus nurture issues, experiments in human engineering, social engineering and projects objectionable to particular religious denominations.

Types of role and task responsibilities mean fulfilling a role or assuming responsibility for a task (e.g. in a job for which the role player usually bears a responsibility regarding acceptable or optimum role fulfilment or task completion). These role duties

may be assigned in a formal way or be more or less informal. When representing a corporation or an institution the roles may be legally ascribed.

Universal and moral responsibilities: moral responsibility may be brought into play by a special type of action and in connection with a special role, but it tends to be universal. It is not peculiar to a particular person or role, but applies to everyone in the same situation and/or role. Morality and moral responsibility are universal. Moral responsibility is individualized in the sense that it cannot be delegated, substituted, replaced, or removed from the particular person (or corporation/institution). It cannot be diminished or divided up, nor can it dissolve or vanish by being borne by a number of people. In this sense it is irreplaceable and irreducible.

Formal training in ethical issues: There is a general complaint that universities tend to neglect ethical issues. This applies to most disciplines. The various professions such as medicine, law, psychology, etc. usually function according to strict ethical codes but many of the other sciences seem to disregard these issues. Certain principles are applicable to science and technology in general and should receive more attention in the training of students.

It could therefore be argued that university curricula should include ethical programmes for their students. The following issues should receive attention in the execution of research: integrity and accuracy; appropriate skills; fabrication; falsification; plagiarism; errors of judgement or errors in the interpretation of results; questionable research practices; the rights of the researched and researchers; intellectual property rights; publishing and when not to publish, etc.

HST in African context

The situation in South Africa can no longer be seen in isolation from the rest of Africa. Forje (1989) draws attention to the fact that the development of "S&T" in Africa as a whole is in a sorry state.

Poverty and political instability have taken their toll and hardly any money is available for S&T. Few African states seem to realize that economic and social development depend on S&T. Researchers in the natural sciences receive very little encouragement and those in the human sciences are more often than not better paid than their colleagues in the "hard" sciences. This unfortunately leads to an influx of students studying the human sciences in universities and consequently aggravates the situation (Forje, 1989 p.87).

Forje (1989, p.87) describes the situation as follows:

> The rush for the humanities and unemployment amongst graduates is a common trend in all African countries. Many factors contribute to this. Generally, university education in Africa has not been coupled with commensurate expansion of the private and public sector dominated economies, leading inevitably to increasing unemployment and the social destabilization that goes along with it. The slow increase in the number of scientists and engineers/technicians can also be attributed to the way the government's scholarship award policy system favours the humanities relative to other disciplines. Such disparity kills interest in lower ranked disciplines; administrators are usually highly graded and well paid.

Africa urgently needs expertise from other countries to assist it in combating its numerous problems while at the same time providing opportunities for these African countries to develop their own expertise. In this respect it was encouraging to learn that influential African scientists, such as Tindimubona (1991) and Nyongo (1992) warned that science should not be regarded as a Western idea and a luxury for developing countries. Tindimubona (1991) summed it up as follows: "While borrowing from external sources is beneficial, no society has ever developed on imported know-how without mobilizing its indigenous capacity to generate S&T and to harness them as internal engines of growth."

Conclusion

Worldwide political changes are creating opportunities for global collaboration in science and technology as well as for the exploitation of science and technology. (The CSIR report [1991] refers to the globalisation of technology.)

A healthy balance should be found between technological development and research. Engelbrecht (1991) talks about a symbiosis between science and technology, and warns that directed fundamental research should not be abandoned in favour of technology. He states that there is a strong connection between directed fundamental research, applied research and technology which is analogous to the roots, the branches and the fruit of a tree. No fruit is possible without the roots. Technology cannot flourish outside an environment of dynamic scientific activity.

Stronger competition will lead to a shorter period between discovery and application, to accelerated adaptation and to shorter time before commercial innovation occurs.

Increased use will be made of multidisciplinary teams, in other words the use of researchers in the human sciences, those specializing in technology production, designers and sales people. A new breed of scientist in the human sciences will have to be trained in future to perform the roles of social engineers and social technologists. The days of hobby-horse research, and research for the sake of research no matter how irrelevant, have probably gone for the time being. Cost-effective relevant research that can be implemented by way of technology and that has an impact on society will be the norm.

Closing remark

As pointed out at the beginning of this chapter, the purpose of this book is to propagate the term HST and to make researchers in the human sciences aware of the fact that they are actually producing technology. This, in fact, should be regarded as a passing phase. In terms of the S&T paradigm, the human

sciences form part of the universal world of science. Science is science be it natural or medical or social. The same applies to technology. It is not necessary to distinguish between natural science technologies and HST. If the human sciences were to take up their rightful place alongside the other sciences we should simply talk about technology. Anything added to this term is superficial and unnecessary.

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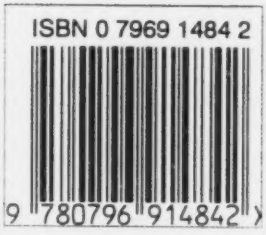
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